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Rubber Research Scheme (Ceylon).

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ERRATA.

" Dr. G. Verhaar is acknowledged in the Introduction to the Special Issue on Better Natural Rubber as being attached to the Indonesian Institute for Rubber Research. This is incorrect; Dr. Verhaar is Director of the Central Chemical-Technical Division of the Experimental Section of the C. P. V."

NOTICES

DARTONFIELD ESTATE — VISITORS' DAY

The services of technical officers are available to visitors on the second Wednesday in each month; the estate superintendent is available every Wednesday. Visitors are requested to arrive on the estate not later than 9-30 a.m.

Visitors will be welcomed at the station on other days provided an appointment has been made in advance.

Dartonfield Estate is situated about 3½ miles from the main Matugama-Agalawatta Road, the turn-off being near culvert No. 14/10. The distance from Colombo is approximately 47 miles.

PUBLICATIONS

Rubber Research Scheme publications comprising Annual Reports, Quarterly Circulars and occasional Bulletins and Advisory Circulars are available without charge to the Proprietors (resident in Ceylon), Superintendents and Local Agents of Rubber estates in Ceylon over 10 acres in extent. Forms of application for registration may be obtained from the Director. Extra copies of publications can be supplied to the Superintendents of large estates for the use of their assistants.

It will be appreciated if subscribers will return any back publications which are of no use to them.

ADVISORY CIRCULARS

The undernoted Circulars may be obtained on application at 25 cents per copy. Future issues in the series will be sent free of charge to estates registered for the receipt of our publications:—

(1) Notes on budgrafting procedure (revised June, 1943).
(3) Notes on Rubber seedling nurseries. (Revised September, 1943).
(4) Contour lining holing and filling, cutting of platforms, trenches and drains (revised June, 1943).
(5) Straining box for latex (January, 1940).
(6) Notes on the care of budded trees of clone Tjirandji 1 with special reference to wind damage (September, 1938).
(8) Planting and after-care of budded stumps (revised June, 1943).
(10) Root Disease in replanted areas (August, 1939).
(14) Rat Control (September, 1940).
(17) Tapping young budded trees (Revised 1947) and two Supplements.
(18) Rubber manuring under wartime conditions. November, 1942).
(20) Planting material recommended for use (1944). (Revised May, 1944) and Supplement.
(21) The Control of Bark Rot and Canker. (April, 1944).
(22) Oidium Leaf Disease. (April, 1944) and two Supplements.
(23) Uniformity in the Nomenclature of Clones and Clonal Seedlings. (December, 1944).
(24) Treatment of Brown Bast. (December, 1944).
(25) Ground Covers. (January, 1945).
(26) Clonal Seed as Planting Material. (July, 1947).
(27) Collection and Planting of Clonal Seed. (April, 1949).
(28) Oidium Leaf Disease.

PLANNING FOR THE FUTURE.

An address delivered by the Director of the Rubber Research Scheme to the Sabaragamuwa Planters' Association in May, 1950.

CEYLON exported some four tons of Rubber in the year 1900 and so we may regard 1950 as marking a half century of rubber export. During this period, production has risen from 4 to 100,000 tons. The rubber industry covers 650,000 acres, and has an export value of some 200 million rupees even when the price is low. Even so it accounts for a quarter of the Island's income. The importance of the industry needs no emphasis.

What of the future of this great industry ?

Consideration of this problem can be divided into two parts. Firstly, what is the future of the Natural Rubber Industry as a whole and secondly, what are Ceylon's prospects of retaining a share in the Natural Rubber Industry ?

I think that there is undoubtedly a sound future for natural rubber, provided that its quality is good and its price right. Sections of the market will be lost from time to time to speciality synthetic products, but new and increasing uses for natural rubber should more than offset these losses.

The answer to the second question—What of Ceylon's share ?—is not so easy, and I welcome this opportunity of bringing this matter to public notice.

The bulk of Ceylon's rubber is aging seedling rubber. The latest figures for replanting are not available to me, but are probably of the order of 10%. Increasing labour costs and an uncertain future lead to caution in taking on the expenses of replanting. When prices are low, the tendency is to regard rubber as a dying industry and replanting as not worth while. When prices are high, rubber is too valuable to cut out, and in any case prices in the past have fluctuated violently with high levels followed by depressions, with the result that maximum crop is extracted while prices stay high, and replanting is forgotten.

Other countries are generally in a much more favourable position. For instance, Indo-China is largely planted with young budded rubber, with a potential production per acre far ahead of Ceylon's.

When peace returns to the politically troubled East, Ceylon's rubber industry will be in an unfavourable position to compete in the world market—unless steps are taken at once to forestall these difficulties.

To my mind, two things are required. The first is official (i.e. Government) encouragement to step up the rate of replanting. The encouragement to be effective must take the practical form of financial aid. The question is not whether Government can afford it, but whether Government can afford to let an industry die. What crop will replace rubber ? What can supply the 200 million rupees at present provided by rubber ? Party Government is notoriously short-term minded, but this matter transcends Party Government. It is vitally concerned with the Island's future—not two or five, but ten and twenty years hence.

If 20,000 acres were replanted each year, an incentive bonus of Rs. 100/- per acre would cost only 1% of the average annual income from rubber, and would probably save many millions in subsidies in the form of relief benefits in years to come. Within twenty years, the industry could be put on a very sound basis.

The second thing required is a new outlook in the rubber industry. There is no wonder that the Americans raised objection to increasing the price of rubber, for they felt that methods are archaic and that improvements in the industry itself could appreciably reduce production costs. It should not be forgotten that America has very appreciable rubber holdings in the East, and American authorities are consequently in a favourable position for knowing just what natural rubber can be produced for. Their attitude, briefly, is that they refuse to subsidise incompetence.

To a large extent, the rubber industry has remained static for the last twenty years, and there has been a marked absence of critical planning for the future. As one example of this non-critical attitude, I will mention the question of seedling v budded material. In any seedling field, the best yielders give possibly three to four times the average. This may be due either to an environmental effect (more than a fair share of space, or a pocket of good soil, etc.) or it may be genetic. Small scale yield tests on derived clones are believed to sort out the genetic factor. If, then, proven genetically-high-yielding rubber is propagated and planted, yields of three to four times the seeding average might be expected. But this expectation does not materialise in practice. In fact, it is a debatable point whether budded rubber gives any better yields than good seed. Either testing methods are wrong—or the environment is unable to support high yields. These same testing methods have proved very useful with other crops and in other countries and so it would seem that environment is preventing our budded rubber from doing its best. A further indication to the same end is the well known fact that small blocks of budded rubber of the order of an acre, even under estate conditions, give very appreciably higher yields than large commercial blocks of the same clone. Have we not relied too much in the past on high quality material, and not enough on high quality agriculture ?

The present system of growing rubber developed as the pioneers of the industry learned about rubber planting and rubber management by experience. The tremendous body of experience gained by these pioneers was never committed to paper, and is rapidly being lost. These pioneers were often owner-managers with a direct interest in each and every tree. But the system has changed. Estates are owned by absentee proprietors. Along with this has gone a change in management. No longer does one man overlook an acreage of such a size that he can know each and every tree, bnt the present trend to economies in management has led to the consolidation of estates into large units, so that one man may overlook 2000 or more acres. To protect their industry, the absentee proprietors adopted a system whereby a successful planter "audited" their estates. But this highly desirable, and even essential system has become distorted so that one man may now direct rather than "audit" activities over tremendous areas.

Each and every rubber tree is an individual—it is the product of its heredity and of its environment. Production line methods can be applied to agriculture only with the assurance that maximum returns will *not* be obtained. There is still untold magic in "the eye of the master."

If there is to be a renaissance in Ceylon, there must be a reversal of the present tendency to economise on management. Sheer pressure of administrative duties prevents the managers of large properties from devoting their time to the growth of the rubber tree. Even if they had the inclination, they cannot become agriculturists for they have to be administrators. Trees which are never seen, and are never treated as individuals, can never give their maximum yield.

One result of all this is that the practice of rubber growing is fast becoming stereotyped, and is being reduced to a series of printed instructions, like running an assembly line. The *art* of rubber growing is being lost, and with it, and all the wealth of expeience it includes, goes much of the hope of future improvement. The remedy is simple. There is room on estates for 'men of the trees' as well as for 'men of the books.'

This brings me to my next point. One man's experiences may not in themselves give a clear picture of cause and effect. They may and often do, in practice, lead to a very distorted view. It is only when these many individual experiences are lumped together, and compared one with the other that the underlying truth begins to emerge.

Collecting all these experiences is by no means an easy task. Too often; younger men are afraid to record their experiences in the presence of older men, and too often more experienced men remember only parts of, and not the whole of a story so that their records are apt to be biassed.

It is the younger men who on the whole make the big advances in investigation. Older men with their maturer judgment and wider experience *can* help the younger ones very materially by placing their knowledge and experience at their disposal.

It is the younger men who will make or mar Ceylon's future in rubber. If they become submerged in the present routine of administration and not agriculture, the industry will undoubtedly decline.

The Rubber Research Scheme can help very appreciably in the renaissance of the growing of rubber. It should be the collecting centre for information. It is specially equipped with facilities for experimentally testing new ideas under critical conditions. I hope that the Scheme will soon be able to organise once again discussions on rubber growing where practical experiences may be related. Such discussions create new ideas and will generate a new outlook in the industry. Then and only then, will Ceylon have a sound and progressive rubber industry which can face the future with confidence. Then and only then, when the Industry uses its Research Scheme to the full, will the Scheme fulfil its real destiny and be the spearhead of the fight for future prosperity.

Director, R.R.S.

Research Laboratories,
Dartonfield,
Agalawatta.
DV.
28th November, 1950.

NATURAL RESISTANCE TO LEAF MILDEW OF HEVEA BRASILIENSIS BY CLONE LCB. 870

BY

H. E. YOUNG, D. Sc. Agr., Oidium Research Officer.

Introduction.

WHEN the occurrence of Leaf Mildew of *Hevea brasiliensis* was first reported and described by Arens (1918) in Java he suggested as a control measure that immune strains of Hevea might be obtained by selection. A search for such immune strains on estates was prosecuted in Java and later in Ceylon.

Isolation of a Resistant Clone.

In 1928 in Java top budding experiments were commenced using as crowns other species of Hevea. Those used were *Hevea collina, H. guianensis, H. spruceana and H. confusa.* These were all budded onto high stumps of *H. brasiliensis* (Bobilioff 1929) with the object of placing a resistant crown on the higher latex producing tapping panel. At the same time further attempts were made, with the aid of planters, to find resistant strains of para rubber.

In the same year one clone LCB. 870 was noted by Cramer (Maas 1934) to show resistant qualities towards leaf mildew. A translation of the relevant part of this paper is of interest :

"The purpose of making crown buddings may be different. In 1928 we (the Government Agricultural Enterprises) began research in order to find mildew-resistant crowns and we succeeded very satisfactorily. Clone LCB. 870, budded in 1928 upon about 100 seedlings at a height of about eight feet, forms crowns with a gradual wintering. They have leaves all through the year ; only a few branches winter in the dangerous period.

Mildew attack, which can do considerable damage to other clones in the neighbourhood, is of no practical importance in this case.

The characteristic of gradual wintering of the mother tree is hereditary and other mildew resistant clones should be looked for in the first instance amongst those showing gradual wintering.

But LCB. 870 is not a high yielding clone and for this reason cannot be used as an ordinary budding, but its strongly growing crown has a remakable influence upon the development of the stem. It should therefore be possible to improve a poorly growing clone with a high production per inch of the tapping cut when a strongly growing healthy crown is budded upon it."

The gradual wintering described has not been noted in Ceylon and, as will be described below, is not the reason for this clone's resistance to mildew.

This reference to a resistant clone was noted by the Rubber Research Scheme (Ceylon) and when in 1937 R. K. S. Murray, Botanist of the Rubber Research Scheme (Ceylon), officially visited Indonesia he investigated this report with the result that arrangements were made with the Java authorities

to obtain budwood for propagation in Ceylon. In January 1940 budwood of this clone was received and propagated at the Nivitigalakele Estate of the Rubber Research Scheme.

Testing for Resistance.

In the meantime arrangements had been made to establish a clone trial museum on Kepitigalla Estate. This was made possible by the co-operation of the Kepitigalla Rubber Estates Ltd., and its Superintendent Mr. M. Atkinson in providing the necessary land and assistance. The museum was planned for the purpose of setting out plots of all the important Hevea clones as well as ones likely, from report, to show any resistance to leaf mildew. In all 59 clones including LCB. 870 were planted there in 1941-42.

The location of the museum is at 1560 feet in the severely affected mid country elevation of the Matale District.

Annual observations of growth and mildew attack on the various clones have been made since then. Twenty four trees were set out in each plot.

The mean girth in inches at three feet of a sample of the clones in January 1949 was :

LCB. 870	24.3	ins.	Mean annual increment	3.43	ins.
HC. 28	21.0	,,		3.00	,,
PR. 107	18.0	,,		2.57	,,
PB. 86	16.0	,,		2.28	,,
RRIM. 501	9.0	,,		1.28	,,

Some plots of different clones succumbed in part or whole to continued mildew attack and all the remaining clones with the exception of LCB. 870 showed retarded growth due to leaf mildew. Clone LCB. 870 wintered for the first time in 1949. The age at which this clone winters first is thus more than that of other clones. A girth increment of three inches per annum is usually considered a good average standard for young *Hevea brasiliensis* trees. It will be seen therefore that clone LCB. 870 has been growing vigorously and that of the other clones HC. 28 is the only one to have reached the required girth standard.

Severe mildew attack has annually affected all clones save LCB. 870 and during the wintering period of 1949 this was the only clone to successfully refoliate. All other clones suffered recurrent leaf fall with each flush of new growth.

The accompanying photograph (plate 1) illustrates the satisfactory canopy produced by LCB. 870 as compared with its neighbouring clone BR. 2.

The observation by Maas quoted above that LCB. 870 undergoes a gradual wintering has been found to be incorrect under Ceylon conditions. This clone winters normally in Ceylon after eight years of age. It is probable that the observations reported by Maas were made on trees of prewintering age. At Kepitigalla and elsewhere in Ceylon some mildew occurs on very young leaves of LCB. 870 and a slight amount of leaf fall of the young bronze leaflets results but not enough to cause any noticeable thinning of the foliage. The more mature stages of the young leaves are not attacked, whilst attack of intermediate stages results in some leaf spotting but no defoliation or distortion.

Basis of Resistance.

Investigations were then carried out to enquire into the reason for the resistance of clone LCB. 870 to mildew attack and an anatomical study of the leaves of eight clones including LCB. 870 was carried out at various stages of leaf development. The clones chosen for study were representative of those reputed to have some resistance to leaf mildew and of those highly susceptible with intermediate types as well.

The clones used and their reputed characteristics in regard to mildew susceptibility were :

LCB. 870	Highly resistant.
PB. 86	Some resistance
TJ. 1	Susceptible
RRIM. 501	Susceptible
LCB. 1320	,,
PR. 107	Some resistance
BD. 5	Very susceptible
PB. 6/9	Very susceptible

The daily sampling of leaflets from the time of bud break to leaf maturity and later sectioning and microscopic examination revealed an interesting phenomenon. It was found that in the majority of clones the first measurable sign of cuticle development appeared suddenly at the seventh to eighth day of leaflet age and that maximum cuticle thickness was observed on the 18th to 22nd day. In the case of Clone LCB. 870 initial cuticle appearance occurred at the same time as with the other clones but development however was complete by the 10th day.

In all the clones including LCB. 870 maximum cuticle thickness varied closely around the mean of 3.65 microns and when the cuticle was first observed it varied closely around a mean of 1.46 microns in thickness. This initial appearance of cuticle takes place in a matter of hours and there is then a gradual increase in thickness until the maximum is reached. The thickness of cuticle was shown to be constant over the leaf blade at any one time.

In only one case does there appear to be a different cuticle make-up to that of the other clones. This occurs in clone PB. 86 where the cuticle under the microscope appears tougher and harder than with the other clones. In other respects it appears the same. This fact possibly accounts for the slight resistance to *Oidium hevea* observed and generally reported for this variety.

In the observations recorded the plants used were in a budwood propagation nursery where the plants were growing under closely similar conditions. The observations in the case of the different clones were made over the same period (May 1950) and are the mean results of a number of observations for each clone. The leaflets were measured from the tip to the base of the petiole of each leaflet. The size of a mature leaflet varies considerably for any one clone.

Reference to figure 1 (a) shows the size of leaflet of the individual clones at cuticle maturity under the same conditions. By cuticle maturity is meant maximum thickness of cuticle. In the case of clone LCB. 870 it is seen that full cuticle development was reached when the leaf was 17 cms. in length. Whereas in the other seven clones the leaflet size was greater being largest with clone PR. 107.

In the histogram (fig. 1 b) showing time of leaf maturity it will be seen that in the case of LCB. 870 the maximum leaflet length was reached in 10 days. This was also the case with clone PB. 86 with the other clones time of

PLATE I.

Clone trial for mildew resistance at Kepitigalla Estate. Resistant clone LCB. 870 (left foreground). Susceptible clone BR. 2 right. Severely affected old seedling rubber in background. Photo 1950.

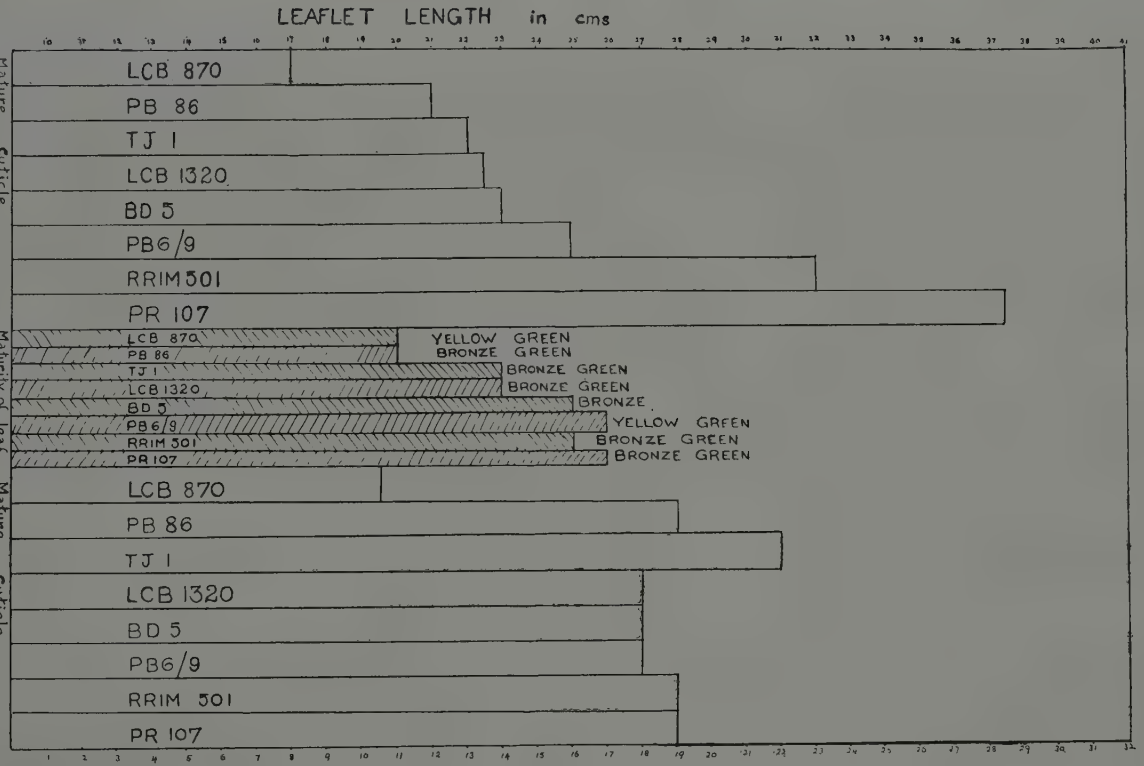

FIGURE 1.

Natural Resistance to Leaf Mildew of H. brasiliensis

leaf development was longer. The length of time taken to reach maturity does not correspond in all cases with the relative size of the leaflets. That is, the rate of growth of a leaflet varies somewhat in the different clones. It was particularly noticeable that, in the case of clone LCB. 870, the growth of the leaflet takes place at a uniform steady rate whereas in the other clones growth was spasmodic.

Reference to the same figure (fig. 1 c) illustrates the time taken for the development of a mature cuticle for each of the clones. Here again it is seen that clone LCB. 870 reaches maturity in a much shorter time than do the other clones. This is highly significant when considering liability to mildew infection.

Figure 1.

Histogram showing A. leaflet length in relation to cuticle maturity. B Age of leaflet at maturity. C. Age of leaflet at cuticle maturity.

It is also shown on comparing the histograms (figs. 1b and 1c) that in the case of LCB. 870 cuticle maturity is reached before maximum leaflet size is attained. In all other clones the cuticle is not fully developed until after the leaflet has fully expanded. The colour of the leaf appears to have no constant relationship, when considering all clones, to time of maximum leaflet size or maximum cuticle development and varies from bronze to yellowish green.

Inoculation Tests.

When the fact that the resistant clone LCB. 870 attained early leaflet maturity was established in comparison to the relative late maturity of the other normal clones investigated it became necessary to check these results by inoculation experiments with the mildew fungus *Oidium heveae*. It is relatively easy to infect leaflets in the susceptible young stage with this fungus by using a suitable technique such as will be described in a later paper. The difficulties experienced by other workers in this regard have been satisfactorily overcome. Observations made of such artificial infections established the fact that to cause leaf fall the spores must germinate on a leaf in the early part of its development. It takes up to five days after spore germination on a susceptible Hevea leaflet for perceptible macroscopic damage to the leaflet to be noted and a longer period for sporulation and serious leaf deformation to occur.

In addition, as has been shown by a number of previous investigations, when a leaflet becomes infected in the later stages of leaf development the mildew spot makes little progress and is limited to a small area and causes little damage. In the present investigations it was found that this limitation of damage occurred when the cuticle developed and the necrotic area was thus circumscribed and only spotting and not leaf fall occurred. A single mildew colony spreads by putting out mycelium over the leaf surface and producing haustoria which penetrate the leaf surface and then again growing on from this point. When the cuticle thickens the haustoria are unable to penetrate the cuticle and the spread of the colony is stopped. Of course if a mildew spore alights on a mature cuticle no colony can develop as the germ tube with its appressorium and subsequent haustorium is unable to enter the leaf and the fungus withers and dies.

Discussion.

In the case of LCB. 870 there is only a short period in which damage can be caused and the leaflet must be infected within the first day or two after bud burst and the intensity of infection must be heavy if any serious

damage is to result. Later infections are abortive owing to the rapid development of cuticle. With other clones the susceptible period before cuticle maturity is much longer as has already been shown and the fungus has sufficient time to develop and cause serious damage.

The susceptible and danger period of leaflets are plain when one considers the fact that a normal leaflet takes about 18 days to reach cuticle maturity and safety. The mildew spore takes about five days to make any impression on the leaf surface and no serious damage occurs for about 6 days after spore germination i.e. the last week of this 18 days is unimportant because of proximity to cuticle maturity and immunity. This leaves twelve days of the eighteen for damage to occur. When a leaf bud opens the leaflet is folded and takes 3-4 days to open the leaf blades, during this period and especially in the first day or two, infection is unlikely owing to the small exposed surface area and the folded position of the leaflets. This may further decrease the effective infective period. In the case of LCB. 870 the calculation arrived at is about three days of effective susceptible time. This allows of a low probability of heavy infection and of slight damage to the leaflet in the resistant clone as compared with normal clones as in the latter case the fungus has sufficient time to develop to harmful proportions whereas in the former this time is greatly limited.

Possible Uses of LCB. 870.

The valuable qualities of resistance and vigour possessed by LCB. 870 are offset by its low yield. Preliminary tappings indicate that in the 9th year of age and second year of tapping a yield of between 300 to 400 lbs. of rubber per acre can be expected. This low yielding factor was mentioned by Maas in his report. Communications with the authorities concerned in Indonesia have failed to elicit further information on yield of the older trees which were established there, as all pre-war records of this clone were lost during the Japanese occupation.

The idea of top budding with this clone, as suggested by Cramer and commenced experimentally in 1928 (Maas 1934) in order to provide a resistant vigorous top on a high yielding tapping panel is worthy of consideration. The early top buddings carried out by Cramer, and described by Maas would have given valuable information on this subject but apparently the records of this experiment were also destroyed during the wartime occupation of Indonesia. The early observation that a top of this clone was having notable stimulating effects on the growth of the tapping panel were however suggestive.

Work carried out in Java (Archief voor de Rubber Cultuur 20e. 1936) showed that when a strong growing crown was budded onto a backward but high yielding tapping panel the yield of the latter was improved in proportion to its increased girth increment and conversely a weak growing crown depressed the yield of the tapping panel as a result of low girth increment. This fact had previously pointed out by Van de Hoop and Ostendorf (Archief Rubburc, XVI., 1932).

The results of the experiments of the above authors showed that

(1) Girth averages for the stocks under the faster growing clones are higher than for non budded trees at the same height, the growth rate of the stocks running parallel to those of the scions.

(2) The number of latex vessels in the stock is independent of the number in the scion.

(3) The yield of the stock per unit part of tapping cut is independent of the scion, i.e. the effect of the scion on yield of stock various with the girth of the stock as governed by the effect of the scion.

This being the case a crown of a very vigorous and healthy clone such as LCB. 870 will probably increase the production of normal tapping panels.

Experiments in this regard were commenced in 1949 when a set of over 250 pairs of twinned seedlings were top budded with LCB. 870 and TJ. 1 at the Hedigalla estate of the Rubber Research Scheme. One of each pair of twins was budded with LCB. 870 and the other with the high yielding clone T.J. 1. Direct comparison of the yields of these pairs of twins will, when in tapping, give a positive answer to this question. In the present initial stages of the experiment, the crown buds of LCB. 870 have proved very vigorous and have grown away much more vigorously than TJ. 1, and even than the stock shoots, and in less than 12 months have caught up with the stem diameter of the stocks. Yearly girth measurements and other relevant observations are being taken. Budding was carried out at a series of heights in order to determine the effect of the distance of union from tapping cut on yield as there is some evidence that nearness to bud union may affect the yield of the tapping cut.

A further series of experiments has been commenced at the clone museum at Kepitigalla and on commercial estates wherein an attempt is being made to work over high producing clones, whose yield has been seriously depreciated by persistent mildew attack at high elevations, to LCB. 870 by top budding in branches and trunks. Budding has been successfully carried out directly on trunks and branches of twelve year old trees. In addition numerous buddings of younger stocks in mildew affected areas have been carried out for observation purposes.

Breeding for Resistance.

Attempts have been made to produce high yielding resistant clones by cross pollinating clone LCB. 870 with high yielding varieties. These pollinations will be continued each flowering season. It is planned to carry out preliminary resistance tests of the resultant nursery seedlings by cuticle investigations in order to save valuable time. In this regard it was found at last year's pollinations that the inflorescence of LCB. 870 is susceptible to mildew damage as in other clones. A satisfactory seed set was however obtained.

The production of graft chimaeras has been carried out with some other plants with the purpose of producing a plant consisting of tissues derived from the two mother plants. That is a desirable strain of plant can be produced which however has the surface of a less desirable but disease resistant variety. These chimaeras may be propagated vegetatively. In most cases however the probabilities of achieving such composite plants are low and in most instances such composite plants do not appear to have come into commercial use. Buddings of LCB. 870 with bud shoots close to the stock tissues are being watched for the possible occurrence of a chimaera with the surface tissue of LCB. 870 and the yielding tissues of a higher yielding clone.

Distribution of Budwood of LCB. 870.

An endeavour has been made to persuade estates, particularly in mildew danger zones, to establish small plots of LCB. 870 for future use, in particular for top budding work and a sizable budwood nursery of this clone has been established at Dartonfield in order to cope with any demands for this budwood. Supplies of budwood of this clone have been sent to the

Rubber Research Institute of Malaya who following reports from Ceylon desired to obtain this clone for experimental purposes.

General.

In some midcountry areas where other crops for various reasons, are unsuitable and rubber due to mildew depredations, is gradually dying out it may prove practicable and profitable to plant the resistant clone LCB. 870 as budded stumps or better still to top bud clonal seedlings or clonal buddings with LCB. 870.

Reference to the literature concerning the "South American Leaf disease" of *Hevea brasiliensis* caused by the fungus *Dothidella ulei* reveals that this serious disease which limits planting in South America runs much the same course as leaf mildew in that only the young immature leaves are susceptible. It therefore seems probable that resistance to this disease also depends on cuticle development and that clone LCB. 870 may prove resistant to this disease which has fortunately not yet reached the eastern rubber producing countries. Occurrence of this menace in the East might well spell disaster to Eastern rubber and the risk of introduction of this scourge must always be considered. It is reported that some fairly resistant low yielding clones and varieties have been isolated in South America and are advocated either as seedling planting or as top buddings on high yielding Eastern clones. It would seem important therefore to have clone LCB. 870 tested for resistance to *Dothidella ulei* and if this test is favourable to provide top budded material in the East as an insurance against this disease.

The project of breeding resistant and high yielding material is a long term policy and in the meantime it is possible that a clone with the required characters may yet be found amongst the seedling populations on rubber estates. It therefore behoves estate superintendents to be watchful for the occurrence of such a plant amongst the trees in their charge.

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AN ALTERNATE HOST OF HEVEA MILDEW.

BY

H. E. YOUNG, D. Sc. Agr. Oidium Research Officer.

SINCE leaf mildew of *Hevea brasiliensis* (*Oidium heveae*) was first reported in Java in 1918 and during its subsequent appearance in other eastern rubber producing countries there have been various suggestions regarding the original provenance of this fungus.

Arens (1918), author of the first report on the subject, suggested that it had adapted itself to the rubber tree from some other host. This theory is well justified since the fungus has never been recorded on Para rubber trees from the South American region where the genus Hevea is endemic.

In 1900 a species of mildew was described on *Euphorbia pilulifera* in Java by Raciborski (Schweizer 1928). This fungus is otherwise morphologically similar to *Oidium heveae.*

Petch (1921) thought that Hevea mildew must have spread from some other euphorbiaceous plant but reported that his attempts to infect rubber seedlings with mildew from *Euphorbia hirta* and *Phyllanthus niruri* in Ceylon were unsuccessful. Both plants occur naturally in Ceylon.

In 1925 Stoughton Harris confirmed Raciborski in his report that the mildew on *Euphorbia hirta was* morphologically identical with rubber leaf mildew. Harris tried cross inoculations with this fungus between *Hevea brasiliensis* and *Euphorbia hirta* but obtained negative results with this and other euphorbiaceous plants.

Bally (1927) also considered the possibility that Hevea mildew can grow on other plants and vice versa. He also obtained negative results in his cross inoculation experiments and was unable, as were other authors, to artificially infect Hevea with its own oidium. The plants which Bally considered as possible other hosts for the fungus were *Manihot dichotoma, Euphorbia hirta, E. rothiana, Phyllanthus niruri, P. reticulatus,* and *Jatropha curcas.*

Schweizer (1928) when studying the mildew fungi of Java noted the occurrence of mildew on some twenty eight plants including *Euphorbia pilufera, Phyllanthus spp.* etc. He obtained unsuccessful cross inoculations, using the oidium from *Phyllanthus niruri,* on to *P. urinaria, E. pilulifera, Indigofera sumatrana* and *Tamarindus indicus.* He did not attempt cross inoculations with *Hevea brasiliensis* or the mildew from that plant.

Bobilioff (1929) mentioned that his search for mildew in rubber fields on other plants growing amongst the rubber was unsuccessful in finding an oidium similar to *Oidium heveae.* Various authors in the meantime referred to the possibilities suggested by Petch and other authors.

Since 1929 further references to work on probable alternate hosts for Hevea mildew cannot be found.

At the commencement of the S. W. Monsoon in Ceylon in 1950 *Euphorbia pilulifera* L. (Syn. *E. hirta,* L.) was found at Dartonfield to be affected with a species of Oidium. The author at the time was searching for species

of oidium on plants in and around rubber plantations and this was the only one at the time which yielded results.

On examination it was found that this fungus was morphologically identical in spore measurements etc. with *Oidium heveae*. This was evidently the same fungus found in Ceylon on this host by Stoughton Harris in 1925 and in Java by Raciborski in 1920 and probably the same as that listed by Petch in 1921 as mentioned above.

Since finding this mildew again it has been observed on the same species of plant in many localities in Ceylon and is particularly common in the drier rubber areas (rainfall around 80 inches per annum). The plant is a semi prostrate annual herb which frequents well drained sunny places such as road sides and paths. It does not grow well with heavy competition or in shade. It is known to the Sinhalese as Budadakiriya and to the Tamils as Palavi.

The plant is distributed throughout the tropical areas of the world and was described in Ceylon many years before Para rubber was first introduced and the Oidium on *E. pilulifera* was, both in Java and Ceylon, recorded some considerable time before leaf mildew of rubber was first reported in 1918 and 1925 respectively.

Oidium is present on *E. pilulifera* in Ceylon, throughout the year even during the heavy monsoon rains. This was also stated to be the case in Java by Schweizer (1928). The leaves of the plant are thickly clothed with fine hairs which effectively shed the rain drops keeping the actual leaf surface comparatively dry and thus providing ideal conditions for mildew development, that is a high humidity and a dry surface.

The infected host plant itself exhibits typical mildew symptoms with the white powdery fungus growing over the leaves followed by leaf desiccation and leaf fall. The plants when heavily infected ultimately die from successive leaf sheddings but in the meantime develop large numbers of viable seeds which reproduce the species.

When this fungus was found at Dartonfield early in 1950 inoculations of young *H. brasiliensis* leaves with spores from the *E. pilulifera* mildew were attempted. The method used was to dust spores from infected *E. pilulifera* leaves on to the leaf surfaces of young rubber plants. This resulted in the appearance of typical *O. heveae* colonies forming on the rubber leaves. The inoculations were carried out many times with similar results, Leaf mildew of rubber produced by initial inoculations from *E. pilulifera* has been successfully kept growing on young leaves of potted rubber plants at the Dartonfield laboratories at will.

The most effective method of artificial inoculation was found to consist in picking an affected *E. pilulifera* leaf which was vigorously sporing and inserting it in the axils of young drooping leaflets of a rubber plant while the rubber leaves were in a receptive condition. By this means constant success was obtained. Field trials involving the inoculation of young rubber trees growing in the field also gave positive results and even during the heavy South West Monsoon some infection though scant was achieved.

Rubber leaf mildew as caused by infection from spores from mildew affected *E. pilulifera* leaves is identical in symptoms and vigour with similar infections artificially produced by inoculations with spores from typically mildewed *H. brasiliensis* obtained either from natural or artificial infections.

In view of the identical morphology of the mildew occurring on *H. brasiliensis* and *E. pilulifera* and of the fact that the oidium from *E. pilulifera*

produces typical leaf mildew of *H. brasiliensis* it is evident that the two diseases are the same and are caused by the same fungus which has been relegated for convenience to the form species *Oidium heveae.*

An examination of the literature and the above instance of transfer of the fungus from another plant to *H. brasiliensis* gives reason for doubting the host specificity of the fungus known as *Oidium heveae* and indeed it seems likely that this form species is not specific.

Out of some seventy nine species of Oidium described from various hosts and surveyed in this project thirty named species agree in spore measurements with *O. heveae* and it seems possible if not probable that of these some at least must be host variants of the same fungus.

Unfortunately in the tropics the perfect stages of powdery mildews are normally absent and as it is from this stage that the correct identity of these fungi is determined methods of inducing ascospore formation or other roundabout means must be found before the fungi can be properly determined.

Cross inoculation studies involving infection of Para rubber plants with powdery mildews from other plants and vice versa are being proceeded with in order to clear up the host relationships of powdery mildews which occur in rubber producing areas and a search for any perfect stages of the fungi concerned is being prosecuted with a view to determining the true identity of the causal fungus of powdery mildew of *H. brasiliensis* as well as the host range of the organism concerned.

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OIDIUM LEAF DISEASE

General

OIDIUM leaf disease is caused by a powdery mildew fungus. In some countries this disease is known as Hevea "mildew". The causal fungus is *Oidium heveae*.

The fungus attacks young leaflets during refoliation and causes a leaf fall, or, if the leaves are slightly more mature at time of attack, the results are a distortion and spotting of the leaflets. Severe foliage injury and shedding due to mildew have an immediate depressing effect on yield. Results of investigations show that one complete defoliation may reduce the annual yield by over 20%. Another very important effect of mildew attack is the checking of growth so that bark renewal is seriously retarded. Repeated defoliations in the one season use up the tree's reserve food supplies resulting in branch and twig dieback and scanty foliage renewal with small leaves. Secondary fungi such as *Diplodia theobromae* enter the dead tissues and are able to cause serious damage by extending the dieback and even killing the trees.

The refoliation season of 1949-50 was particularly severe in regard to mildew damage and was fairly general throughout the rubber growing districts. Even the low-country rubber received a serious setback.

Oidium heveae was first reported in Ceylon in the Kalutara district in 1925 and is now firmly established in the main rubber growing areas. The intensity of attack varies from year to year with climatic conditions and is normally very severe at mid-country elevations. In the low-country the disease in different years varies from mild attacks on late wintering trees to more severe incidence such as regularly happens at higher elevations.

The severity of attacks can be expected to vary year by year. The main conditions favouring serious attack are high humidities with absence of rain during refoliations. Cloudy conditions are favourable to severe attack and scattered showers and mists are not adverse to rapid mildew growth.

The fungus has not varied in virulence from year to year but a bad attack in one year results in the widespread distribution of the fungus which leads to a more severe incidence the following year if climatic factors are favourable.

Causal Fungus

The causal organism (*Oidium heveae*) has very delicate spores which can only survive exposure to direct sunlight or dry atmospheres for a very short period. In consequence spread of the disease is gradual from leaf to leaf and tree to tree. It does not carry any distance in one stage.

The spores germinate in an hour or two on a plant surface but the germ tube will not enter a wet surface; it grows away from it and withers off and dies. On a dry plant surface it grows towards the surface and causes infection by penetrating the surface tissue. In continuous wet weather only protected dry surfaces such as the undersides of some leaves and the hair covered flower shoots are subject to infection.

When a spore settles on a susceptible surface and germinates it is some days before any sign of infection is visible to the unaided eye although the fungus has already established itself. The germ tube is unable to penetrate the mature *Hevea brasiliensis* leaf cuticle and consequently mature leaves are immune to attack.

Development of leaf cuticle

In the vast majority of seedlings and clones the leaf cuticle takes eighteen or more days to reach maturity from time of bud break. In one clone imported from Java by the Rubber Research Scheme in 1940 the cuticle reaches maturity in ten days. This clone is LCB. 870 which unfortunately is a low yielder of latex producing between 3-400 lbs. per acre in the second year of tapping, but may prove of considerable value in breeding and for top budding purposes for resistance. Experiments in these aspects have been commenced by the Rubber Research Scheme.

As it takes about five days for mildew attack to be visible it will be seen that the most dangerous part of any leaf history will be during the first half of the cuticle development period. If infected in the latter half of this period only spotting can result as the fungus will have an immune cuticle to attack by the time it has got going. In the case of clone LCB. 870 the period is greatly lessened resulting in the comparative resistance of this clone to mildew attack. It is attacked slightly but grows so rapidly through the susceptible stage that damage is comparatively slight. Some clones such as TJ. 1 (which has a 22 day maturing cuticle) have a longer susceptible period and, weather conditions being favourable, are more severely attacked.

Clonal susceptibility

In general late wintering clones are most severely affected. This is due to the building up of the fungus population on earlier wintering varieties so that the late winterers became heavily inoculated. However if much rain supervenes, the attack on the late winterers may be curtailed. Seedling rubber fields are frequently severely attacked due to the variation in refoliation times between the different trees causing a build up of infection and severe attack on the late wintering trees plus infection of the second flush of leaves of the earlier wintering trees.

On the other hand, early wintering clones frequently escape much attack due to the small amount of infection present at the beginning of the refoliation season.

Topographical factors in infection

Trees on well ventilated slopes and hill tops are usually more severely affected than those on corresponding sheltered slopes and depressions. Fogs and rain wet the leaf surfaces. These surfaces dry out quicker on exposed sites and the spores are then able to infect the leaves. In sheltered spots the leaf surface remains wet longer causing more difficulty for the infection process.

Variations in exposure and soil also cause variations in refoliation time with consequent mildew effects according to the climatic factors during the respective periods of susceptible leaf development.

Seasonal Incidence of Mildew

Hevea mildew is known for its effects at the time of refoliation. The fungus however is present throughout the year on new shoots. Owing to the comparatively sporadic production of these and unfavourable weather conditions the fungus is not usually noted unless especially sought after. It occurs as isolated poorly developed spots on young leaves here and there through the canopy and on young volunteer seedlings. With the onset of favourable conditions and a plentiful supply of suitable leaves for growth it rapidly propagates again.

Alternate Hosts for Oidium heveae

The causal fungus is also to be found on a common weed where it is present throughout the year. Climatic factors do not affect the development of the fungus on this weed as much as they do on Hevea. The leaves of the weed are clothed with plentiful long fine hairs which prevent wetting of the leaf surface and the spores of the mildew are able to infect the leaf surface despite continuous wet conditions. Hevea leaves are easily infected with the fungus from this weed causing typical leaf fall. The fungus on the weed is *Oidium heveae*, and the weed is *Euphorbia pilulifera*. L. (Syn. *E. hirta;* Sinhalese—Budadakiriya; Tamil—Palavi). This plant belongs to the same laticiferous family as Hevea but is a low growing semiprostrate herb which frequents road sides etc. It grows best under conditions of good drainage and little shade.

This weed is probably another important method of inter-seasonal survival of the mildew. It is particularly common in the drier areas and some attention should be paid to it during weeding operations.

Mildew and flowering

Hevea mildew can cause an almost complete flower drop. The stems of the inflorescences are hairy and provide a more protected surface for spore germination than do Hevea leaf surfaces. As with the leaves the effect of the mildew is superficial. It causes breaks in the cuticle and excess evaporation takes place through the broken surface resulting in the drying out of the affected flower stems and leaves.

The male flowers being on the sides of the flower shoots and the females terminal the male flowers drop first.

If severe flower fall is caused it is usual for a further flush of flowers to appear later in the same season. This frequently escapes mildew attack due to the wetter conditions prevailing and decreased mildew population giving less chances of infection.

Effect of Manures on Incidence of Mildew

Trials in Ceylon and elsewhere have shown that manuring is not effective in preventing mildew attack. Manuring close to the wintering period leads to increased mildew damage owing to the fact that the manuring causes a later defoliation than normal. Manuring however is considered to be of value in assisting trees to recover from the effects of leaf mildew.

Control of Leaf Mildew

At the moment the only method of control recommended for general use is sulphur dusting and this is considered necessary for most areas. Even in the low-country the effects of *Oidium heveae* attack in the last season were very severe.

Sulphur

There are three main factors to consider in choosing a suitable dusting sulphur.

(*A*). **Fineness of division of particles.** This is most important. The finer the particle size the better the fungicidal value of the dust and also the more sulphur particles per given weight. Fine particles adhere to the leaf surfaces better, they float better in the air and, being more of them, they produce more particles per leaf area than coarser dusts, with consequent better fungicidal effect. Sulphur kills the mildew by volatilization of the sulphur and therefore the larger the surface area of the particle compared with its mass, the better the volatilization. This means the finer the particles the better. Sulphur for dusting purposes should be able to pass through a 300 mesh sieve (U.K. specifications) or a 325 mesh sieve (U.S.A. specifications) *i.e.* the largest particle should not exceed 47 microns in diameter (1 micron = 1/1000 of a millimetre). A number of samples of sulphur dust examined have proved to have too large a particle size to be of efficient fungicidal value.

(*B*). **Purity of the Product.** The more sulphur in the dust the more economical as it is the sulphur which does the work.

In some products inert diluents are added for the purpose of making the dust more free flowing by preventing aggregation of sulphur particles. Wettable properties are also claimed. Latest scientific opinion is not inclined to favour the presence of these products. It has been found that when wetters are added the particles are more liable to wash off. The best sticker is a fine particle. When buying sulphur dusts with additives one pays for the additives as well as the active ingredient—the sulphur—and a heavier application may be necessary.

(*C*). **Free flowing properties.** If thoroughly dried, sulphur flows well. It should be stored in a dry place and if inclined to "ball" it should be spread in the sun or factory and thoroughly dried out and sieved prior to use.

Examination of Sulphur

The Rubber Research Scheme carries out examination of sulphur dust samples (2—3 oz.) and reports on their suitability for dusting purposes free of charge. When forwarding such samples it is essential that the sulphur be well mixed before taking the sample.

Dusting Machines

Sulphur is applied to the trees by a power driven dusting machine. A fan is driven by a small engine and the sulphur is fed from a hopper into the fan casing or resultant air stream and blown through an outlet. The rate of delivery of dust can be controlled by adjusting the feed outlet from the hopper.

The motor is usually a two stroke type air cooled one. This type of motor however is subject to overheating and the resultant stoppages cause delays. The four stroke engine runs continuously and soon makes up for its extra cost in continuous working time.

The whole machine is slung on poles and carried by 4-8 men according to the terrain and weight of machine. The latter varies from 170 lbs. to 250 lbs. empty. The hopper capacity is usually about 56 lbs. For use on roads and paths the machine may be mounted on a two wheel trolley or on the back of a car or truck.

One make of machine by means of a specially designed delivery outlet, delivers a turbulent cloud of dust which hangs about and gives very efficient coverage over a wide range. The usual type has a straight chimney outlet with no resulting turbulence and does not give such a good cloud and is not so successful.

Field technique

The essence of sulphur dusting lies in the intelligent use of air currents. If the air is still the dust, with the usual type of machine, rises up above the trees and falls again and does not carry far. A strong wind is unfavourable unless blowing down or up a steep slope since it prevents the sulphur cloud from rising. Ideal conditions are caused by a light steady wind which allows the dust to rise sufficiently and also carries it through the foliage.

The wind is usually capricious and the cloud must be watched closely to ensure that the whole field is well treated. It is often possible to dust an appreciable area such as a narrow valley from one position by waiting for puffs of wind in the right direction; otherwise it is customary to transport the machine through the field while working. It becomes easy to judge when the required quantity of sulphur per acre is being applied.

One hundred acres per day is a good average area to be dusted in one day. This will vary according to wind, machine, and terrain. With suitable paths and a trolley or truck this area can be greatly exceeded.

Intelligent and close supervision is essential for effective dusting.

Sulphur dosage per application

Ten to twelve pounds per acre per round is considered the minimum normal dose to give adequate control. Lower dosages do not produce frequent enough sulphur particles on the leaves and even in a light attack are insufficient, *i.e.* the application rate must not be lowered even if a light attack is experienced. This dosage is recommended for both low and mid-country elevations.

Lower dosages have been found in practice and experiment to give relatively ineffective control.

Time and Frequency of Dusting

Finely divided sulphur remains active on a leaf for the limited period of about two days after dusting and because the foliage must be protected until the cuticle of the majority of leaves has matured it is obvious that a number of dust application must be made to cover the period of refoliation.

Dusting must therefore be done every seven to ten days until refoliation is considered complete. This period should ensure that the mildew is unable to produce spores between dustings. A longer period is apt to be dangerous in this respect, and with such delay the mildew may get out of hand.

As initial infection comes from mildew spots on late shoots etc. dusting, to have maximum effect, must commence when defoliation of the old leaves begins and before the new buds break. This allows control of the infection foci to be achieved in order to prevent initial spread and build up of the attack on the newly opening buds which appear shortly after. Sulphur dust does

not completely kill out an established mildew spot; it merely controls it and prevents it producing spores. If the interval between any two dusting rounds is unduly prolonged the mildew fungus on lesions already dusted begins to produce spores again from the edges of the spots. Dusting therefore must be carried out to a fixed schedule once commenced and continue until refoliation is complete.

The influence of rain on the effectiveness of sulphur dust is of little importance.

The chance of infection of treated fields from neighbouring nontreated areas is relatively small. It is thus possible to dust badly attacked or early or late wintering areas without it being necessary to dust the whole plantation or division. The number of rounds of dusting required will vary. With seedling fields more will be required than with budded monoclonal fields.

Oidium and Phytophthora leaf fall

In the low-country districts control of Oidium has been complicated hitherto by the theory that control of mildew may lead to increased Phytophthora damage during the S.W. Monsoon owing to increased fruit setting, the fruits being regarded as the foci of Phytophthora infection. To this end it was suggested in a previous circular that dusting should not commence until the mildew was affecting the young leaflets. Experience however has shown that if the attack is allowed to progress to such a stage dusting is ineffective in preventing severe leaf fall and must be commenced much earlier and prior to infection spread.

Further doubt has been thrown on the Phytophthora complication by the substantiation of the fact that the casual fungus of Phytophthora leaf fall *P. meadii* is really *P. palmivora* the same fungus that causes black stripe and patch canker, *i.e.* this fungus is already present in the fields whether there are fruits present or not and exists in dead and dying twigs seedlings etc. In any case it is considered unwise to allow leaf mildew to progress unchecked and suffer the consequences for the sake of achieving a questionable reduction in a hypothetical attack of Phytophthora leaf fall at a future date. The control of Phytophthora leaf disease in Ceylon for its own sake is now being considered.

Roads

Sulphur dusting operations can be facilitated and expedited by the provision of roads and paths designed to give dusting access to all parts of each field, so that it is seldom if at all necessary to take the machine off the access routes. This allows of the machine being mounted on a trolley or other vehicle. Where sulphur dusting is an annual routine it is certainly advisable to improve existing paths so they may be negotiated by some sort of vehicle and in replanting old rubber, provision for such access paths should be made. This will cheapen and otherwise facilitate dusting operations during the life of the crop. As supervision is absolutely necessary the provision of such paths and a vehicle will make less demands on the supervisor's time which becomes important on large areas. With rising labour costs the use of less labour by mechanization becomes imperative.

Budded Rubber

The time of defoliation in a stand of one clone is much more uniform than in a field of mixed seedlings. In some clones notably T.J. I there is a tendency for different branches of the same tree to winter at different times and in such cases wintering may be as prolonged as in a seedling field.

The uniformity of wintering within monoclonal blocks is favourable to the control of Oidium owing to the shorter period during which the foliage is susceptible to attack. On the other hand if dusting is at all delayed in such a case a large proportion of the new leaf may be lost before control can, with difficulty, be established.

In the case of blocks planted with clonal seed the wintering period will be prolonged as in the case of mixed seedling rubber and dusting operations must therefore also be prolonged.

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November, 1950.

A PLAN FOR REPLANTING RUBBER WITH THE MINIMUM LOSS OF CROP.

R. H. COLLING, Moralioya Group, Ruanwella.

FROM recent observations and talks with many Rubber Planters I am forced to the conclusion that the full merits of a systematic slaughter tapping and replanting programme are not appreciated, and it is my hope that the following scheme may help to avoid much unnecessary loss of crop.

The slaughter tapping yields are based on my own experience on the Densworth Division of this Group, and the expected yields from replanted areas are, I think, conservative in view of present indications.

There are certain conditions essential for the successful operation of the programme :—

1. The District must be suitable for rubber.
2. The rubber to be replanted should normally yield about 400 lbs. or more per acre.
3. Previous tapping should have been reasonably good and the rubber should have received normal applications of manure over the last decade ; in which case manuring of the old stand can cease at once, although some Directors may care to manure for a few years the last 4 fields to be replanted.
4. The systematic slaughter tapping programme must be adhered to and receive the *most careful supervision*.

   In this connection (a) at 400% intensity all trees must be properly marked for upward tapping, and a tappers task should not exceed 80 to 90 trees, (b) tapping over the whole area must be intense (slight wounding is tolerated) and all thin bark trees must be tapped.
5. Last, but not least, we must have successful replanting.

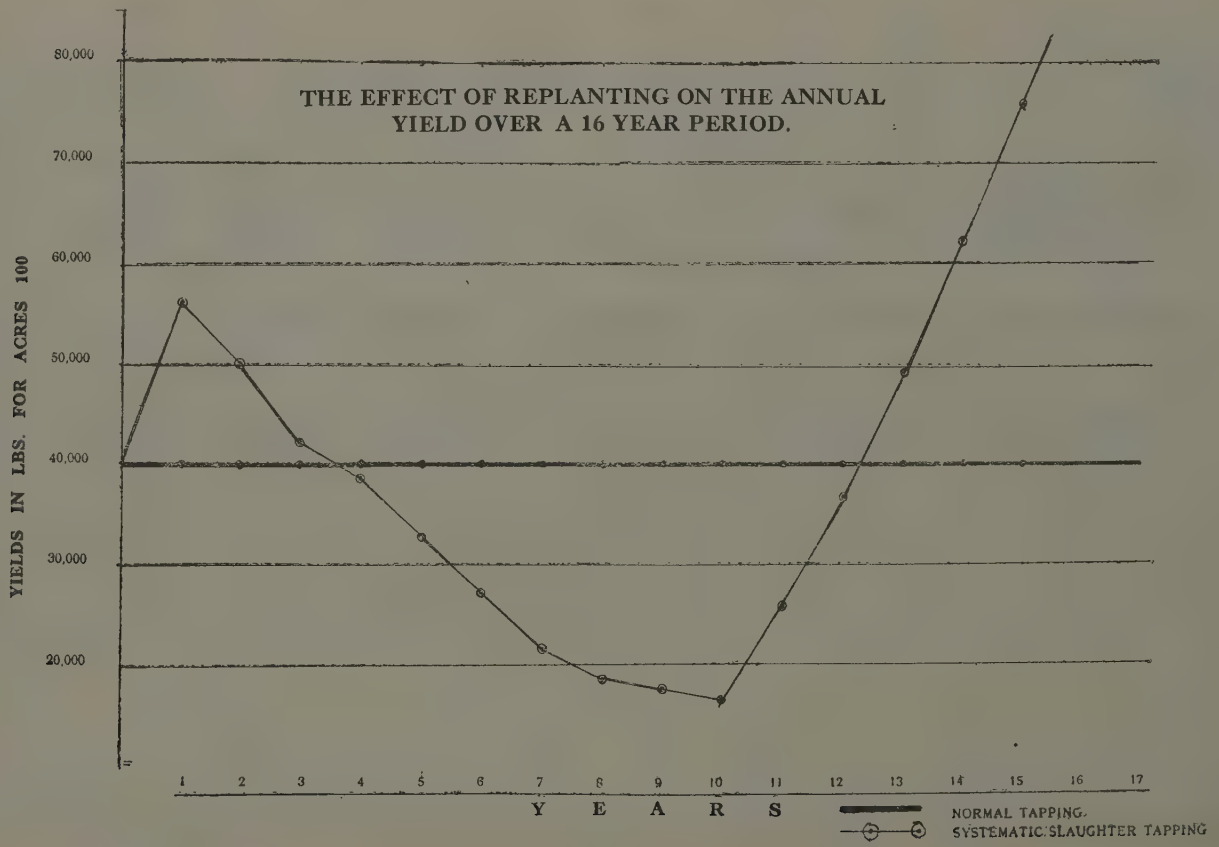
   The figures appended are based on a 100 acre unit divided into nine fields and the tapping systems are as follows :—

   4s/2, d/2, 400% (two normal and two upward half spirals)
   2s/2, d/2, 200% (two normal half spirals)
   2s/2, d/3, 133% ,, ,, ,, ,,

   It is interesting to note that the total crop which can be expected over a period of sixteen years with systematic slaughter tapping and replanting exceeds the normal crop of say 400 lbs. per acre over the same period, and that there is no loss of crop until the seventh year.

Proposed Slaughter Tapping & Replanting Programme.

	Field No.	Acres	Tapping % Intensity	Yield lbs. per Acre	Crop	Total
1st Year	1	11	400	850	9,350	
No Replanting	2	11	200	700	7,700	
	3—9	78	133	500	39,000	56,050
2nd Year	2	11	400	800	8,800	
Replant No. 1	3	11	200	700	7,700	
	4—9	67	133	500	33,500	50,000
3rd Year	3	11	400	800	8,800	
Replant No. 2	4	11	200	650	7,150	
	5—9	56	133	500	28,000	43,950
4th Year	4	11	400	800	8,800	
Replant No. 3	5	11	200	650	7,150	
	6—9	45	133	500	22,500	38,450
5th Year	5	11	400	800	8,800	
Replant No. 4	6	11	200	600	6,600	
	7—9	34	133	500	17,000	32,400
6th Year	6	11	400	800	8,800	
Replant No. 5	7	11	200	600	6,600	
	8—9	23	133	500	11,500	26,900
7th Year	7	11	400	800	8,800	
Replant No. 6	8	11	200	600	6,600	
	9	12	133	500	6,000	21,400
8th Year	8	11	400	700	7,700	
Replant No. 7	9	12	200	600	7,200	
No. 1 in bearing	1	11	100	300	3,300	18,200
9th Year	9	12	400	700	8,400	
Replant No. 8	1	11	100	500	5,500	
	2	11	100	300	3,300	17,200
10th Year	1	11	100	700	7,700	
Replant No. 9	2	11	100	500	5,500	
	3	11	100	300	3,300	16,500
						321,050


THE EFFECT OF REPLANTING ON THE ANNUAL YIELD OVER A 16 YEAR PERIOD.
YIELDS IN LBS. FOR ACRES 100
80,000
70,000
60,000
50,000
40,000
30,000
20,000
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17
Y E A R S
NORMAL TAPPING.
SYSTEMATIC SLAUGHTER TAPPING

Proposed Slaughter Tapping & Replanting Programme.

	Field No.	Acres	Tapping % Intensity	Yield lbs. per Acre	Crop	Total
						321,050
11th Year	1	11	100	850	9,350	
	2	11	100	700	7,700	
	3	11	100	500	5,500	
	4	11	100	300	3,300	25,850
12th Year	1	11	100	1,000	11,000	
	2	11	100	850	9,350	
	3	11	100	700	7,700	
	4	11	100	500	5,500	
	5	11	100	300	3,300	36,850
13th Year	1	11	100	1,100	12,000	
	2	11	100	1,000	11,000	
	3	11	100	850	9,350	
	4	11	100	700	7,700	
	5	11	100	500	5,500	
	6	11	100	300	3,300	48,950
14th Year	1	11	100	1,200	13,200	
	2	11	100	1,100	12,100	
	3	11	100	1,000	11,000	
	4	11	100	850	9,350	
	5	11	100	700	7,700	
	6	11	100	500	5,500	
	7	11	100	300	3,300	62,150
15th Year	1	11	100	1,200	13,200	
	2	11	100	1,200	13,200	
	3	11	100	1,100	12,100	
	4	11	100	1,000	11,000	
	5	11	100	850	9,350	
	6	11	100	700	7,700	
	7	11	100	500	5,500	
	8	11	100	300	3,300	75,350
16th Year	1	11	100	1,200	13,200	
	2	11	100	1,200	13,200	
	3	11	100	1,200	13,200	
	4	11	100	1,100	12,100	
	5	11	100	1,000	11,000	
	6	11	100	850	9,350	
	7	11	100	700	7,700	
	8	11	100	500	5,500	
	9	12	100	300	3,600	88,850
						659,050

YIELDS OF BUDDED RUBBER & CLONAL SEEDLINGS IN COMMERCIAL TAPPING.

C. A. DE SILVA, BOTANIST.

THIS article presents the yields from budded and seedling rubber areas in commercial tapping on estates in Ceylon. Previous articles in the present series will be found in the following publications :—

1. Combined Third and Fourth Quarterly Circulars for 1945, Vol. 22, Parts 3—4, p. 10.
2. Combined First and Second Quarterly Circulars for 1947, Vol. 24, Parts 1—2, p. 3.
3. Combined quarterly Circulars for 1948, Vol. 25, Parts 1—4, p. 10.

The 7th questionnaire sent out to estates through the courtesy of their agents brought in the results from over 10,000 acres representing 94 estates. As in previous years failure to obtain returns from few estates has resulted in some discontinuity in the presentation of yield data.

In previous years it was necessary to discard a substantial portion of the yield returns, due to the fact that the information given referred to polyclone areas. In this article the writer has summarised and commented on these results. It has also been possible to elaborate Table III showing the yielding capacity of clones in various rubber growing districts. The difficulties of making close and accurate comparisons of clonal yields from field to field on the same estate and between estates must again be stressed. Variations in age of rubber selected for commencement of tapping, tapping systems, methods of recording tappers' yields on commercial estates, stand per acre of tappable trees, all contribute to the difficulties of comparison and comments. In most cases records are from fields tapped on 100 per cent intensity; any changes are indicated in the tables. Areas of under 5 acres have been discarded except in cases where very limited information is available of the newer clones.

Looking through the tables of yield data it will be evident that as the acreages for yield results increase and are more representative of the general variable terrain of rubber growing land in this country, the yields per acre do not come up to the same high standard of the same clones planted on a few acres, perhaps on a particularly favoured area of the estate. Experience has shown that environment can have a profound effect on the high yielding qualities of selected clones. A clone's performance on its estate of origin is not always an indication of its potentialities in other districts and soil types. This is more strongly applicable to imported clones than to clones that have been developed under our own conditions of growth.

Table I presents the yields of the older clones TJ. 1, TJ. 16, BD. 5, BD. 10, PB. 25, AV. 49, and AV. 50.

Clone TJ. 1.—This clone still remains the most widely planted of the older clones. Its yield is outstanding compared with the other clones. It should be noted that the acreage of this clone in most cases is the highest

within a single estate, thereby giving added weight to its superiority. The clone can be grown in most districts, but owing to its susceptibility to wind damage, it should not be grown in very exposed areas. It presents difficulties in the control of Oidium, owing to somewhat irregular stages of defoliation of its leaf canopy during the wintering period. Other defects such as its inability to stand up to 100 per cent intensity tapping during the early years, and precoagulation of latex in the field still exist under certain conditions.

There is little doubt that this clone is now being fast superseded by clone Prang Besar 86, which has high yield without the defects attributed to clone TJ. 1. Apart from the question of yield the existence of large blocks of Clone TJ. 1 is also of considerable value to estates as a source of selfed clonal seed. TJ. 1 seed has done well in other countries and is becoming increasingly popular in this country.

Clone BD. 5.—This clone again shows very high yields on several estates compared with Clone TJ. 1. It is known to be susceptible to diseases of the tapping panel and Phytophthora dieback of young stems. These clonal characteristics present special difficulties in the first years of growth. On account of the clones undesirable secondary characters and indifferent growth on poor types of soil, it has not been recommended for large scale planting.

Clone TJ. 16.—It has not come up to the standard of clone TJ. 1 in the wet low country districts. Good yield results obtained in the Kurunegala and Matale districts show that the clone is suitable for the drier areas. Its late wintering habit often makes it susceptible to severe attacks of Oidium. It is a good seed parent and crossed with TJ. 1 should produce high quality clonal seed.

Clone BD. 10.—This clone also shows good yields on estates sending in returns, but is not up to the standard of clone TJ. 1. It is known to grow well on poorer types of soil. Estates have in the past commented on a tendency for renewed bark to be somewhat corrugated and a flattening-out of the main stem, but these defects are not a great deterrent to tapping.

Clones AV. 49, AV. 50, and PB. 25.—These clones must now be relegated to a class that finds no favour in any scheme of large scale planting at the present time. However there is evidence that clone PB. 25, which is a robust grower can stand up to a 133 per cent intensity tapping, if the double-three tapping system is introduced about the 4th tapping year. At Dartonfield Clone PB. 25 reached the 1000 lb. per acre level on the double-three system in the 6th tapping year, without an unduly high incidence of Brown Bast.

Clones GL. 1. PB. 86, and HC. 28.—The yields of these clones are given in Table II together with yields of clones TJ. 1 and 16, where possible, for comparison :—

Clone Glenshiel 1.—The yields of this clone compare very favourably with those of PB. 86 and TJ. 1 and its inclusion in our list for large scale planting in the past was fully justified. In exposed areas with favourable soil conditions the clone is particularly useful against wind damage and may be in many instances a better choice than Clone TJ. 1. It is safer to start the clone on a 67% intensity tapping, as its yielding capacity per tree is in general higher than that of Clone TJ. 1. Owing to its light crown the tree does not girth as quickly as other clones and may on this account come into tapping 6 to 12 months later. The clone does not thrive in polyclone areas and should not be included with the more vigorous growing clones. At the

present time it is doubtful whether the clone will come in for serious consideration in further replanting programmes owing to reports of the 'unstable' condition of its latex for certain purposes.

Clone PB. 86.—There is little doubt now that this clone is the best we have for large scale planting. The clone has stood the test of commercial tapping under various conditions of growth in this country and its acreage can be greatly increased on estates undertaking large scale replanting. The clone stands up to Oidium leaf disease quite well in most years. The clonal seed of PB. 86 has become somewhat popular in Ceylon although there are no yield data available to justify this. The early results of PB. 86 clonal seedlings have not come up to expectations in Malaya but the planting of this seed cannot be condemned on this account. It is, however, necessary to be cautious by not adopting the planting of large acreages with the seed of a single clone parent like PB. 86.

Clone HC. 28.—This clone has given very satisfactory yields, but owing to its yellow latex, it is unlikely that further planting of this clone will be undertaken on most estates.

The yields of the older clones planted on a large scale for the various planting districts in Ceylon are summarised in Table III. In general there has been a fair increase in acreages representing the various clones in the early tapping years. Later tapping years are still poorly represented and can only be developed over a number of years. On the whole the actual yields per acre obtained are not up to the expected standards for the class of clones under review. The yields of 1000 lbs. and over are confined to very small acreages. While the yields of budded rubber are an improvement on those obtained from old seedling rubber, the results from these older replanted budded areas are definitely disappointing. The causes for this failure to reach expected standards require careful investigation. In the previous article the writer expressed the opinion that better standards of yield can be expected with the adoption of a higher stand of trees per acre. It is also necessary to point out that the effect of environment on the growth and yield of clones can be very marked, and in many cases the best of clones planted on poor land has failed to produce the goods. To counter these difficulties it is necessary to pay very careful attention to cultural operations including manuring, especially during the early years of growth. Every effort should be made to even up the growth before the trees come into tapping. This can only be done by judiciously manuring all backward plants with inorganic and organic artificial manures. The incorporation of green manures and other recognised cultural operations are essential for the improvement of poorer types of soil together with the adoption of sound soil conservation methods. Experience in the past has shown that it is almost impossible to correct backward growth of rubber in areas, where the young plants have been neglected during the first 6 to 7 years of growth. Experienced rubber planters are now able to judge by mere observation backward plants at any particular age and give them the necessary attention. Failure to provide for such attention is very short-sighted policy.

Local clones MK. 3/2 and WG. 6278.—Both these clones have been recommended for the wet low-country districts. A few estates have sent in early yield results of clone MK. 3/2 which are satisfactory. An area planted in 1939 has given 1784 lbs. from 195 trees in 1948. Results for WG. 6278 have not been received. Yield and growth figures of clone WG. 6278 from control blocks in our experimental areas show that the clone is markedly sensitive to environment, especially poor soil conditions, and is on the whole

late maturing. Both clones give a satisfactory white latex for crepe manufacture. Early yield results of hand pollinated seed with clones WG. 6278 and MK. 3/2 indicate that both clones are reliable seed parents.

New Clones: AV. 255, PR. 107, AV. 352, WAR. 4, KD. 1, BD. 17, LUN. N, PB. 6/5, PB. 6/9, PB. 5/60, PB. 6/50, PB. 5/139, PB. 5/122, RRIM. 500 series and RRS. NAB. clones:—

We have again to fall back on our own experimental clearings for indications of the potentialities of these new clones. The numbers of trees tested of each clone range from about 20-25 and unless our results are supported by yield results from small scale plantings on estates, it will not be possible for the Rubber Research Scheme to recommend any of the above clones for large scale planting. Of the clones referred to above, AV. 255, PR. 107, LUN. N, PB. 5/60, PB. 6/50, are promising. The yield results have been published in the Annual Report for 1949. The Scheme has also tested out RRIM. clones of the '500' series and new NAB. clones established at Nivitigalakele from high yielding Tjikadoe seedlings selected from an area on an outside estate. Trials on a small scale have shown that the yields of a fair number of these clones are very promising. Budwood of these clones have been distributed to many estates for small trials.

In previous articles of these series a considerable acreage of mixed clone rubber had to be discarded. Table IV gives a summary for the first time of the polyclone areas. The yields in comparison with those from monoclone areas presented in tables given earlier are very satisfactory. Many clones that have been recommended in the past are well represented on a fair acreage on each estate. The objections raised in the past against polyclone plantings were mainly concerned with undue competition between clones with differences in growing habits, tapping difficulties, and treatment of diseases like Oidium heveae. These difficulties, of course, exist in all seedling areas, especially in clonal seedlings which at the present time are giving very encouraging results. The writer is by no means making out a case for polyclone planting. The results are presented such as they exist in this country.

CLONAL SEEDLINGS.

The yields of imported clonal seedlings from the Prang Besar and Tjikadoe isolated seed gardens are summarised in Tables V and Table VI respectively.

Both these gardens were constituted on selections of high yielders as parents, without any previous knowledge of their breeding characteristics, and it is encouraging to note that the results are very satisfactory as indicated by the performance of the clonal seedlings in Ceylon, especially those from the Prang Besar Gardens, which were laid down in 1928. Considerable breeding work has since been carried out leading to selective thinning out of certain clones from these seed gardens. The laying down of new gardens by the Prang Besar Company with special clone parents for controlled natural crossings will bring the clonal seed from these sources to a high degree of reliability. As pointed out before we have in Ceylon today several approved sources of clonal seed on estates, which planted out clones now known to be good seed parents. We cannot hope to get the same isolation against undesirable pollinations on estates, as adopted for specially laid out seed gardens, but with sufficient care in collecting seed as laid down in our Advisory Circular No. 27, there is little doubt that the reputation of several of these sources for good results will be established within the next 10 years.

Seed of clone TJ. 1, collected centrally from large monoclonal blocks will be of special value as "selfed" seed of this clone has done particularly well in other rubber growing countries. Clonal seedlings from a small isolated block of clone TJ. 1 in Ceylon have given the following results :—

Acreage	Age first tapped	1st Tapping Year		2nd Tapping Year		3rd Tapping Year		4th Tapping Year	
		Trees per ac. tapped	Yield per ac. lbs.	Trees per ac. tapped	Yield per ac. lbs.	Trees. per ac. tapped	Yield per ac. lbs.	Trees per ac. tapped	Yield per ac. lbs.
17	5½ yrs.	30	106	93	477	123	718	123	813

With an initial stand of 134 trees to the acre with no selective thinning out of any kind the above yields are very promising.

The views of the Rubber Research Scheme have been expressed before on the matter of planting clonal seed. It is a matter for estates to try this material out for themselves on a small scale. Many estates have already taken the initiative and planted fair acreages of clonal seedlings. The risk of getting really poor yields is obviously minimised by planting the right 'types' of clonal seedlings at a high initial stand per acre. For the present TJ. 1 'selfed' seed will be the safest choice, while mixed seedlings of the best known clone parents will be a good alternative. Comments on seedlings of clone PB. 86 have been given earlier in this paper.

It is obvious that if better clones are to be developed in the future it will be necessary to have alternative generations of *clonal* budgrafts and clonal seedlings from budgraft crosses in fairly regular cycles on a proportion of the rubber growing land in this country. Hand pollinated seedlings will also play their part in the selection of better clones and clonal parents. In this way one type of planting material may have to give way to the other as new clones are developed and better clonal seedlings are obtained from them.

Notes dealing with recommendations on planting material will not be complete at the present time without reference being made to the latest developments with regard to the standardisation of natural rubber. It will be necessary under these conditions to submit to manufacturers 'specification' rubbers with differences in technological qualities specially suited for various applications.

Although manufacturers have still no special views on the economic significance of 'specification' rubbers, it will be necessary for the plant-breeder in the future to re-orientate his methods of selecting disirable clones, especially with regard to criteria, which can only be discerned by technological tests. How much of the hitherto recognised high yielding characteristics of clones may have to be overlooked in producing clones with reasonably uniform rubbers and how much such work can be eased by 'blending' rubbers from various sources for uniformity has still to be decided.

The writer once again has to acknowledge with thanks the co-operation of Estate Agents and Superintendents in sending in yield data.

TABLE I.

Yields in lbs. per acre and age in years.

Estate	District	Clone	Acres	6		7		8		9		10		11		12		13		14		15		16		17		18	
				Yield	%	Yield	%	Yield	%	Yield	%	Yield	%	Yield	%	Yield	%	Yield	%	Yield	%	Yield	%	Yield	%	Yield	%	Yield	%
822	Passara	TJ. 1	26															583		811	100	818	100	633	100	778	100		
		BD. 5	14																	581	72	520	64	495	78	616	79	611	
284	Kalutara	TJ. 1	203-19	382	100	556	100	732	100	798	100	768*	100	877*	100	708*	100	663*	100	643*	100	665*	100	885*	100	1042			
		TJ. 16	62- 9	154	40	281	51	400	55	575	72	522	68	556	63	513*	72	479*	72	679*	106	661	99						
		BD. 5	102-42					430	59	674	84	844	110	1073	122	1152	163	1293	195	1052	164	1170	176	1198	135				
		AV. 50	22					316	43	608	76	617	80	715	82	716	101	625	94	740	115	405	61						
		PB. 25	17	448	117	391	70	523	71	506		553*	72	721	82														
350	Kalutara	TJ. 1	10	346	100	582	100	608	100	554*	100	626*	100	827	100														
		TJ. 16	10	319	92	567	97	645	106	458*	83	539*	86	748	90														
		BD. 5	10	348	100	528	91	498*	82	596*	108	806	129																
		BD. 10	10			566	97	616	101	533*	96	597*	95	858	104														
218	K. V.	TJ. 1	8									777	100	866	100	1052	100	1010	100	1042	100	840*	100						
		BD. 5	7									741	95	817	94	1080	103	766	76	943	90	581*	69						
		BD. 10	8									872	112	949	109	1090	104	851	84	975	94	744*	89						
		AV. 50	5									475	61	648	75	880	84	743	74	764	73	695*	83						
688	Ratnapura	TJ. 1	21-81							289	100	359	100	511	100	657	100	821	100	660	100	504†							
		TJ. 16	66									218	61	306	60	266	89	350	43	324	49								
		BD. 5	70							200	69	378	105	472	92	446	67	488	59	373†	56								
		AV. 50	21-61							442	153	503	140	607	119	711	106	703	86	377†	57								
128	Kegalle	TJ. 1	43-65	416	100	662	100	898	100	855	100	954	100	728	100														
		TJ. 16	25	258	62	428	65	568	63	864	101	754	79	600	82														
316	Ratnapura	TJ. 1	7-8											394	100	616	100	748	100	821	100	886	100	750	100	682*	100	395	
		TJ. 16	22							630		519		593	150	657	107	548	73	621	76	561	62	499*	66	314	46		
166	Kalutara	TJ. 1	61	506	100	526	100	614	100	898	100	745	100																
		BD. 5	25	329	65	462	88	509	82	936	104	913	121																
26	K. V.	TJ. 1	29			433	100	665	100	796	100	835	100	870	100														
		BD. 5	24			554	125	800	120	875	110	1047	125	1146	132														
153	Kalutara	TJ. 1	31	387	100	537	100	743	100	764	100	804	100	626	100														
		BD. 5	19	371	96	466	87	782	105	792	104	836	104	1061	169														
476	Galle	TJ. 1	11-22					346		512	100	591	100	732	100	1112*		725											
		AV. 49	9							440	86	696*	117	405*	55														
546	Kegalle	TJ. 1	11			495	100	777	100	898	100	1098	100	1228	100	1323	100												
		AV. 49	7			504	101	642	83	623	70	768	70	852	69	888	67												
168	Kurunegala	TJ. 16	5					829	100	982	100	1225	100	1147	100	969	100	685	100	828	100	884	100	1113	100				
		AV 49	6					601	72	624	63	994	81	814	71	851	88	524	76	888	107	694	79	746	67				
372	Matale	TJ. 1	17½			443*	100	681	100	838	100	1107	100																
		TJ. 16	15½			337*	76	694	102	814	97	939	85																
A	Kegalle	TJ. 1	13	456	100	599	100	820	100	729	100	771	100	882	100														
		TJ. 16	5	168	37	283	47	487	60	377	52	444	58	584	66														
616	Negombo	TJ. 1	20			218	100	428	100	641	100	833	100	960	100	1028	100	1057	100										
		BD. 5	6			276	127	538	126	406	63	981	118	1108	115	1116	109	1155	109										
B	Kegalle	TJ. 1	10	770	100	904	100	1040	100	1045	100																		
		BD. 5	10	353	46	584	65	784	75	825	79																		
356	Kalutara	TJ. 1	18					250	100	274	100	532	100	607	100														
		TJ. 16	18					273	109	286	104	494	93	550	91														
		BD. 5	18					284	114	300	109	598	112	617	102														
		BD. 10	18					251	104	238	87	579	109	509	84														
		PB. 25	18					198	79	236	86	505	95	536	88														
152	Kalutara	TJ. 1	15			320	100	466	100	599	100	854	100	1032		660													
		BD. 5	33			197	62	379	81	623	104	734	86																
131	Kalutara	TJ. 1	13-27	226	100	393	100	529	100	619	100	1018	100	885	100														
		BD. 5	7	189	84	262	67	402	76	671	108	870	85	865	98														
167	K. V.	TJ. 1	45			193		330	100	439	100	563	100																
		BD. 5	25½					226	68	385	88	533	95																
60	Galle	TJ 1	12											631	100														
		BD. 5												645	102														
130	Kalutara	TJ. 1	59	273	100	627	100	602	100	674	100	731	100																
		PB. 25	27			284		451	75	573	85																		
		TJ. 16	50	170	62	408		440	73	472	70	621	85																
172	Galle	TJ. 1	22			259		580	100	569	100	735	100	783	100														
		BD. 10	20					508	88	584	103	763	104	759	97														
		AV. 49	22					394	68	486	85	594	81	555	71														
12	K. V.	TJ. 1	8									1114	100	1134	100														
		BD. 5	7½									645	58	752	66														
127	K. V.	TJ. 1	25½							286	100	385	100																
		TJ. 16	17							320	112	453	118																
808	K. V.	TJ. 1	35½			236	100	367	100																				
		TJ. 16	14¼			258	109	443	121																				
151	Kalutara	TJ. 1	20			263	100	582	100	559	100	572	100	585	100														
		BD. 5	50			314	119	306	53	260	57	655	114	921	157														
93	Kegalle	TJ. 1	25	279	100	487	100	652	100	743	100	873	100																
		BD. 5	21	264	95	432	89	611	94	522	70	750	86																
		TJ. 16	8					304	47	445	60	793	91	608		754													
148	Kalutara	TJ. 1	28					264	100	544	100	710	100	975		1215		836		831		406		836		759			
		PB. 25	4½			480		363	138	636	117	634	89																
350	Kalutara	TJ. 1	10	346	100	582	100	608	100	554	100	627	100	827															
		PB. 25	22	223	64	312	54	438	72	612	110																		
		PB. 86	10	407	118	549	94	568	92	651	117	1053	168																
26	K. V.	TJ. 1	63									502	100	745	100														
		TJ. 16	13									346**	69	462	62														
		BD. 5	87									424	84	567	76														
		PB. 25	50									208**	41	353	47														

* Reduced tapping intensity from 100% to 67% owing to Brown Bast.

TABLE II.

Yields of clones GL. 1, TJ. 1, TJ. 16, PB. 86, HC. 28 in pounds of Dry Rubber.

Estate No. and District	Clone	Acres	Trees per acre		6 years		7 years		8 years		9 years		10 acres		11 years		12 years		13 years	
			Total	In Tapping	Per ac.	Per tree	Per ac.	Per tree	Per ac.	Per tree	Per ac.	Per tree	Per ac.	Per tree	Per ac.	Per tree	Per ac.	Per tree	Per ac.	Per tree
141	GL. 1	19	140	36-125-134-130	136	3.8	326*	3.9	685*	5.5	729*	5.5	825	6.3						
K. V.	TJ. 1	25	140	58-118-121-108	225	3.9	447	3.8	709	6.0	812	6.7	838	7.8						
546	GL. 1	1.5	144	126-127-119-127			299	2.4	377	3.0	822	6.5	952	7.5	966	7.6	1118	8.8		
Kegalle	PB. 86	1	129	118-119-111			497	4.2	817	6.9	747	6.3	1246	10.5	1272	10.7	1711	15.4		
	TJ. 1	11	141	133-124			495	3.7	777	5.8	898	6.7	1098	8.3	1228	9.2	1323	10.7		
172	GL. 1	9	158	91-112-129-144-146			330	3.6	925	8.2	973	7.5	1089	7.6	1403	9.6				
Galle	TJ. 1	21	122	94-97-100-111-112			272	2.9	580	5.7	569	5.7	735	6.6	783	7.0				
350	GL. 1	10	117	95-117-123-123			658	6.9	710	6.1	461*	3.7	684*	5.6	749	6.1				
Kalutara	TJ. 1	10	117	96-99-102-103-104			582	6.1	608	6.1	554*	5.4	626*	6.1	827	7.9				
	TJ. 16	10	117	102-104-105			567	5.5	645	6.5	458*	4.5	539*	5.2	748	7.1				
	PB. 86	10	120	101-104-109-112	407	4.0	549	5.4	568*	5.5	651*	6.0	1053	9.4						
	TJ. 16	10	116	99-101-103-105	392	3.9	544	5.4	455*	4.6	549*	5.3	766	7.3						
153	HC. 28	5	144	129-130-125			401	3.1	563	4.3	639	5.1	722	5.8	770	6.2				
Kalutara	TJ. 1	21	128	115-117-109-105-106			583	5.1	638	7.2	785	7.2	842	8.0	737	7.0				
152	HC. 28	14	99	90-91-96-92-89-94					527	5.8	589	6.5	784	8.3	818	8.9	932	10.5	912	9.7
Kalutara	TJ. 1	8	108	95-100-96-99-96-97					544	5.7	727	7.3	841	8.7	891	9.0	1184	12.3	791	8.2
130	GL. 1	25.5	115	79-102			360*	4.8	535	5.2	671	6.6								
Kalutara	TJ. 1	36	109	91-104-103			603*	6.6	580	5.6	631	6.1	739	7.2						
	TJ. 16	50	114	83-93-106			408*	4.9	440	4.7	472	4.4	621	5.9						
	PB. 86	12	117	106-109			477*	4.5	762	7.0	874	7.2								
	PB. 86	12.5	130	106-123			370	3.5	586	4.8	816	6.6								
107	GL. 1	7	111	73-29-69	479†	6.6	439**	15.1	427	6.1	510	7.4								
Kalutara	TJ. 1	79	123	115-93-113	473†	4.1	610**	6.6	738	6.5	933	8.3								
284	GL. 1	8	133	111-104-133					607*	5.5	574*	5.5	948	7.1						
Kalutara	TJ. 1	29	133	91-82-109					642*	7.0	360*	6.8	700	6.4						
808	GL. 1	14	117	73-95			318*	4.4	545	5.7										
K. V.	TJ. 1	35.5	101	71-85			236*	3.3	367	4.3										
	TJ. 16	14.3	134	75-104			253	3.4	443	4.3										
134	GL. 1	21	121	118-117-107					365*	3.1	586*	5.0	611*	5.2	922	8.6				
K. V.	TJ. 1	22	128	109-118-92					286	2.6	414	3.5	472	4.0	613	6.7				
372	GL. 1	10.5	118	76-118-116			242*	3.2	574*	5.0	668	5.7	1068	9.2						
Matale	PB. 86	7	156	105-125-151			395*	3.8	592*	5.2	774	6.2	1225	8.1						
	HC. 28	5	139	121-135-136			321*	2.7	521	3.9	806	6.0	823	6.1						
166	GL. 1	7.5	157	91-112			502*	5.5	605	5.4										
Kalutara	HC. 28	8.5	135	108-116			480	3.6	658	5.6										
131	GL. 1	10	119	75-101-109			389	5.2	490	4.0	737	6.8								
Kalutara	TJ. 1	27	116	93-100-109-112			423	4.5	462	5.0	619	6.2	828	7.6	885	7.9				
	TJ. 16	13	125	91-50-121-123	298	3.3	362	7.2	596	11.9	619	5.1	1208	10.0	1273	10.3				
	PB. 86	5	117	89-93	334	3.8	514	5.5												
	HC. 28	4	137	122-131-133			469	3.6	712	5.4	894	6.7								
A	GL. 1	2.25	164	93-147-149	408	4.4	444	3.0	716	4.9	520	3.5	1034	6.9	1050	7.0				
Kegalle	TJ. 1	13	170	113-127-131			465	4.1	610	4.8	836	6.6	743	5.8	785	6.0	882	6.7		
	TJ. 16	449	111	42-89-92-99	168	4.0	283	3.2	486	5.5	376	4.1	443	4.5	584	5.9				
391	GL. 1	4	123	118-121-123			440	3.7	348	2.9	385	3.1	482	3.9	751	6.1	930	7.6		
Kalutara	TJ. 1	25	100	88-92-94-98					248	2.8	362	3.9	518	5.5	624	6.4	589	6.0	537	5.5
127	GL. 1	27	133	92							295	3.2								
K. V.	TJ. 1	25½	138	93-112							286	3.1	385	3.4						
	TJ. 16	17	161	125-127							320	2.6	453	3.6						
167	GL. 1	23¼	109	92-96-100					200	2.2	417	4.3	470	4.7						
K. V.	HC. 28	53½	122	96-103-109			232	2.4	352	3.4	468	4.3								
	TJ. 1	45	128	80-111-114-123			193	2.4	330	3.0	439	3.9	563	4.6						
	PB. 86	12	132	98-111			448	4.6	591	5.3										
	TJ. 16	13	122	84-94					206	2.2	280	3.0								
C	GL. 1	10	139	80-85-95			409	5.1	675	7.9	611	6.4	658	6.9						
K. V.	TJ. 1	11	138	80-85-95			294	3.7	595	7.0	743	7.8	531	5.6						
	TJ. 16	14	139	80-85-95			155	1.9	339	4.0	499	5.3	469	4.9						
	PB. 86	9	139	80-85-95			348	4.4	606	7.1	854	9.0	814	8.6						
561	GL. 1	13	145	27-36-40-67	73	2.7	198	5.5	230	5.8	333	5.0								
	HC. 28	10½	148	111-122-123-120			313	2.8	504	4.1	496	4.0	616	5.1						
	TJ. 1	10½	119	84-83					298	3.5	512	6.2								
	PB. 86	8½	117	50-63			174	3.5	348	5.5										
133	GL. 1	12	115	31-56							203	6.5	559	8.5						
	TJ. 1	16	98	71-78-79					334	4.7	454	5.8	473	6.0	599	7.6				
	TJ. 16	16	93	80-78-74					401	5.0	470	6.0	517	7.0						
151	GL. 1	25	114	57-98							253	4.4	415	4.2						
Kalutara	TJ. 1	20	116	86-83-103					582	6.8	559	6.7	572	6.9	585	5.7				
	HC. 28	20	120	112-106-111					468	4.2	614	5.5	616	5.8	684	6.5	705	6.4		
D	GL. 1	13¾	130	88											608	6.9				
Matale	TJ. 1	38¾	138	93											730	7.8				
	TJ. 16	40	136	86											685	8.0				
	PB. 86	16½	136	92									890	9.7						
478	GL. 1	36	118	99									628	6.3						
Kalutara	PB. 86	12	119	102					572	5.6										
148	GL. 1	6	125	125							608	4.9	888	7.1						
Kalutara	TJ. 1	9	112	113-112							641	5.7	605	5.4						
	HC. 28	6	119	97-110-119			465	4.7	302	2.7	569	4.8	742	6.2						
385	GL. 1	30	151	93-149					237	2.5	690	4.6								
Ratnapura	TJ. 16	35	130	89-130	208	2.3	290	3.3	280	2.2										
	PB. 86	38	134	101-126	228	2.3	555	5.5	888	7.0										

* Tapping started at or reduced to 67%.

** Tapping discontinued on trees under 21" girth.

† Tapped for 10 months only.

TABLE III.

Yields in Pounds per Acre per Tapping Year for Planting Districts

District	Kalutara								Kelani Valley								Ratnapura								Passara			
Clone	TJ. 1		BD. 5		TJ. 16		GL. 1		TJ. 1		BD. 5		TJ. 16		GL. 1		TJ. 1		BD. 5		TJ. 16		GL. 1		TJ. 1		BD. 5	
No. of Estate	23		12		11		10		26		11		10		6		18		5		9		1		1		1	
Age in Years	Ac.	lb. per ac.	Ac.	lb. per ac.	Ac.	lb. per ac.	Ac.	lb. per ac.	Ac.	lb. per ac.	Ac.	lb. per ac.	Ac.	lb. per ac.	Ac.	lb. per ac.	Ac.	lb. per ac.	Ac.	lb. per ac.	Ac.	lb. per ac.	Ac.	lb. per ac.	Ac.	lb. per ac.	Ac.	lb. per ac.
6	643	350	54	349	50	325	17	435	313	175	—	—	10	259	4	100	223	277										
7	1055	460	186	346	282	380	74	440	468	324	48	445	92	316	61	270	624	393										
8	1313	566	316	445	257	486	97	524	688	434	120	455	68	350	176	425	612	523	24	256	206	325						
9	1372	650	323	569	316	551	85	637	859	501	241	514	92	334	142	530	876	512	94	293	154	514	12	203				
10	1061	683	283	708	195	596	73	656	908	686	193	651	99	474	58	544	1085	597	90	479	177	453	12	559				
11	639	763	250	802	121	692	10	749	404	814	62	824	19	705	35	777	370	668	70	481	91	614						
12	317	816	108	862	33	672	—	—	236	904	5	710	5	910	4	930	93	598	70	459	91	618	—	—	3	481		
13	272	799	108	975	33	653	—	—	85½	833	10	494	5	709	—	—	93	694	70	507	91	664	—	—	35	612	14	540
14	195	701	64	794	18	748	—	—	60½	833	13½	685	5	680	—	—	90	767	70	400	88	473	—	—	36	698	14	581
15	95	634	64	851	9	661	—	—	66	678	18½	517	5	396	—	—	50	631	14	327	22	561	—	—	66	570	14	520
16	59	857	42	1198	—	—	—	—	66	763	18½	488	5	448	—	—	15	895	—	—	22	499	—	—	64	526	14	495

(Continued)

District	Kegalle								Galle								Kurunegala						Negombo			
Clone	TJ. 1		BD. 5		TJ. 16		GL. 1		TJ. 1		BD. 5		TJ. 16		GL. 1		TJ. 1		TJ. 16		GL. 1		TJ. 1		BD. 5	
No. of Estate	7		3		4		2		7		4		1		1		1		1		1		1		1	
Age in Years	Ac.	lb. per ac.	Ac.	lb. per ac.	Ac.	lb. per ac.	Ac.	lb. per ac.	Ac.	lb. per ac.	Ac.	lb. per ac.	Ac.	lb. per ac.	Ac.	lb. per ac.	Ac.	lb. per ac.	Ac.	lb. per ac.	Ac.	lb. per ac.	Ac.	lb. per ac.	Ac.	lb. per ac.
6	159	445	17	369	26	258	2	399	8	334																
7	136	650	31	482	46	397	4	362	61	305						9	330	11	193			13	198	20	218	6	276
8	113	827	31	669	54	482	4	539	199	393	51	251	32	293		24	707	11	298	5.5	829	13	230	20	428	6	538
9	113	852	25	674	48	505	4	666	202	482	91	413	22	472		24	798	11	512	5.5	982	13	333	20	641	6	406
10	103	894	15	750	48	619	4	982	109	594	65	528				24	927			5.5	1225			20	833	6	981
11	65	760	—	—	48	599	2	966	62	706	25	645				24	1167			5.5	1147			20	960	6	1108
12	10	830	8	601	8	754			18	1029										5.5	969			20	1028	6	1116
13									18	799										5.5	685					
14									7	1165	7	598								5.5	828					
15									7	705										5.5	884					
16																				5.5	1133					

TABLE IV.

Yields of Mixed Clonal Areas in Commercial Tapping in lbs. per acre.

District	Clones	Acres	Age in years 6	7	8	9	10	11	12	13	14	15	16
Kalutara	TJ. 1, TJ. 16, PB. 25, GL. 1	100					542						
	TJ. 1, 16, PB. 183, PB. 25, BD. 5, GL. 1	25					758						
	TJ. 1, 16, BD. 5	35		243	367	546	544	630					
	PB. 86, Mixed	15				256							
	TJ. 1, GL. 1	53.5		423	699	756	889	979					
	BD. 5, TJ. 1, PIL. B. 84, A. 44, PBIG.	28.5			302								
	TJ. 1, GL. 1, TJ. 16, PB. 25, BD. 5	52	195	403	431	644	741						
	TJ. 1, BD. 5, HC. 28	61		283	456	524	711	859					
	TJ. 1, HC. 28, MK. 3/2, PB. 6/9, PB. 5/122 } PIL. B. 84, A. 44, PBIG.	66.5			406								
	PB. 25, GL. 1	59.5			201	446							
	TJ. 1, BD. 5, PB. 186	51	167	—	325	439	496	626					
	TJ. 1, BD. 10	28		277	492	630	744	730	806	693	717		
	BD. 5, TJ. 1, HC. 28	23		267	532	701	748	751	845	747	866		
	BD. 2, 10, TJ. 1, 8, 16, PB. 23, 123, 186, AV. 49, 50, 152	23		324	579	729	901	957	1002	858	958		
	MK. clones, BD. 5, TJ. 1	24.5			254	455	609	637	720	796	738	869	
	BD. 5, HC. 55	35		186	357	587	692	768					
	TJ. 1, BD. 5	12		431	633		770	906	962				
	TJ. 1, 16	15			429								
	TJ. 1, BD. 5	50			374	405	405	362					
	PB. 25, GL. 1, BD. 5	71			363	294							
	Average yields per acre		181	315	421	529	682	746	867	774	820	869	
Kelani Valley	TJ. 1, 16, GL. 1, PBIG.	54.5	178	337	445								
	TJ. 1, BD. 10, TJ. 16, BD. 5, GL. 1	105	273	405	522	594							
	TJ. 1, BD. 5	57	244	373	528	838	957	887					
	TJ. 1, 16, BD. 5, GL. 1	24	—	206	430	695	747						
	HC. 28, PB. 86, MK. 3/2, GL. 1	31			419	581							
	TJ. 1, 16, GL. 1, PB. 25	100				531							
	TJ. 1, AV. 49	100							1086	1116	1085		
	HC. 28, TJ. 1, PB. 25	50						1075					
	HC. 28, PB. 86, PB. 25, TJ. 1, BD. 5	48					1014						
	TJ. 1, AV. 49, TJ. 8, BD. 10	8											1133
	TJ. 1, PB. 86, GL. 1	54	407	567	655	737	662						
	TJ. 16, MK. 3/2	15		175	600								
	TJ. 1, 16, GL. 1	23½	343	541	589	801	922						
	Average yields per acre		289	372	524	682	860	981	1086	1116	1085	—	1133
Mora Wak\	TJ. 1, 16, PB. 25	99¼	—	374	619								
Kegalle	TJ. 16, BD. 5	15½	265	558	676	660	855	702					
	TJ. 1, 16, BD. 5	42	244	492	499	551	617						
	PBIG., PIL. B. 84, PIL. A. 44	25					651						
	Average yields per acre		255	525	588	606	708	702					
Matale	TJ. 1, BD. 5, PB 25.	57				352							
	TJ. 1, TJ. 16	36				520	436						
Ratna-pura	TJ, 1, and TJ. 16	73			430	509	635						
	PB. 86, PIL. B. 84, AV. 163, 157, PR. 2, 107	12.5			293								

TABLE V.

Yields of Prang Besar Isolated Garden Seedlings in lbs. per Acre and per Tree.

Tapping System S/2, d/2, 100%.

Estate	Date of planting PB. seedlings	Date budded in field (F) budded stumps (S)	Acres	Control Clone	Yields in Pounds																	
					1st Tapping Year				2nd Year			3rd Year			4th Year			5th Year			6th Year		
					Age in years	No. of trees	Per acre	Per tree	No. of trees	Per acre	Per tree	No. of trees	Per acre	Per tree	No. of trees	Per acre	Per tree	No. of trees	Per acre	Per tree	No. of trees	Per acre	Per tree
613	6/38		3		5¾	148	548*	3.7	141	807	5.7	140	874	6.2	139	1031	7.4	152	1275	8.4			
		6/38(S)	7	TJ. 1	5¾		462*		130	641	4.9	125	792	6.3	129	911	7.0	107	816	7.6			
166	5/40		3½		6	84	323	3.9	98	674	6.9	115	750										
	1/39		5		5¼	183	541	2.9	154	801	5.2	107!	724	6.8	153	1106	7.2	136	942	6.9			
		6/38(S)	25	TJ. 1	5½	88	547	6.2	112	603	5.4	97!	662	6.8	114	926	8.1	94	671	7.1			
	6/38		5		5¾	157	507*	3.2	154	815	5.3	127	858	6.8	119	1007	8.5	131	927	7.1	131	1500	
		6/38(S)	5	PB. 25	5¾	92	251*	2.7	124	446	3.6	127	609	4.8	123	728	5.9	128	633	4.9	128	881	
153	6/38		13		5¾	57	465*	8.1	85	499	5.9	109	630	5.8	107	871	8.1	104	891	8.6			
	6/39		23		5¾	72	286*	4.0	109	590	5.4	119	826	6.9	119	988	8.3						
		10/37(F)	21	TJ. 1	5¾	115	412*	3.5	115	583	5.1	117	838	7.2	109	785	7.2	105	842	8.0	106	737	7.0
		6-12/37(S)	10	TJ. 1	5½	101	333*	3.2	101	440	4.4	103	643	6.2	94	742	7.9	95	766	8.1	97	755	7.8
220	6/38		10½		5¾		251*	—	95	524	5.0	101	782	7.7	123	1019	8.2	120	1003	8.3			
		6/38(S)	19	TJ. 1	6¾	67	319*	4.8	68	518	7.6	68	552	8.1	94	763	8.1						
107	5/40		55½		6	106	434*	4.1	121	805	6.6	121	982	8.1									
		5/39(S)	79	TJ. 1	6	115	474*	4.1	92!	610	6.6	113	738	6.5									
372	11/39																						
	8/40		12½		5-6	105	329*	3.1	112	464	4.1	116	688	5.9	120	1255	10.5						
		11/38(F)																					
		4/39(F)	17½	TJ. 1	6-7	97	116**	1.2	111	443	4.0	113	681	6.0	118	838	7.1						
203	10/38		13		7	77	263*	3.4	123	627	5.1	138	708	5.1									
		10/37(S)	32	TJ. 1	8	59	261*	4.4	82	542	6.6	97	497	5.1									
	4/38		5½		8	115	663*	5.7	161	821	5.1	165	862	5.2									
		7/38(S)	17½	HC. 28	8	78	303*	3.9	95	464	4.9	109	491	4.5									
536	19/40		14½		5	29	78*	2.7	78	263	3.4	123	782	6.4	134	1046							
		19/39(S)		TJ. 16	5	56	179*	3.4	58	288	5.0	102	491	4.8	116	746							
131	6/40		15		5¾	108	433*	4.0	137	643	4.7	136	907	6.7									
		5/41		PB. 86	6	89	334*	3.8	93	514	5.5												
139†	12/39		5½		7½-8	120	292	2.4	120	707	5.9												
350	7/40		28		7	88	272	3.1	95	390	4.1												
		7/40(S)	22	PIL. B84	7	65	183	2.8	84	349	4.2												
478	11/38		12		6	99	540	5.5	98	577	5.9	97	460	4.7	97	462	4.8						
		1940/41(F)	12	PB. 86	7	50	142	2.8	102	572	5.6												
151	4/38		25		7	82	397	4.9	82	586	7.1	106	667	6.3									
		10/38	10	HC. 28	7½	56	159	2.8	62	457	7.4	109	480	4.4									

! = Tapping discontinued on trees under 21" girth. * Tapped from 8 to 10 months only. ** 6 months tapping.

† Includes 2½ acres of Pilmoor seedlings which yielded less than PBIG. seedlings.

TABLE VI.

Yields of Tjikadoe Seedlings in Pounds per Acre and per Tree.

No. of Estate	District	Ac.	Age in yrs. when 1st tapped	1st Tap. Yr.			2nd Tap. Yr.			3rd Tap Yr.			4th Tap. Yr.			5th Tap. Yr.			6th Tap. Yr.			7th Tap. Yr.			8th Tap. Yr.			9th Tap. Yr.		
				No. of tr.	Per ac.	Per tr.	No. of tr.	Per ac.	Per tr.	No. of tr.	Per ac.	Per tr.	No. of tr.	Per ac.	Per tr.	No. of tr.	Per ac.	Per tr.	No. of tr.	Per ac.	Per tr.	No. of tr.	Per ac.	Per tr.	No. of tr.	Per ac.	Per tr.	No. of tr.	Per ac.	Per tr.
220	K. V.	40	7	73	353	4.8																							
350	KAL.	10	7	99	501	5.1	97	552	5.7	100	452	4.5	104	477	4.6	105	775	7.4											
536	KAL.	7.7	7	97	685	7.1	130	826	6.4	130	712	5.5	130	969	7.5	130	1069	8.2											
392	KAL.	12	7	101	323	3.2	101	446	4.4	105	511	4.9	100	458	4.6														
350	KAL.	50	7	121	514	4.2																							
561	KUR.	14	9	65	155	2.4	66	243	3.7																				
734	RAT.	24	11	92	916	10.0	101	1112	11.0	110	1189	10.8	99	1217	12.3	99	1019	10.3	99	1074	10.8	99	1144	11.6	99	1113	11.2	99	1113	11.2

NOTES ON SOURCES OF CLONAL SEED IN CEYLON.

C. A. de SILVA, *Botanist.*

THE Rubber Research Scheme in recent years with the help of the Rubber Controller's Department has approved just over 100 seed gardens in Ceylon. A complete up to date list is given at the end of these notes. Two Advisory Circulars No.'s 26, and 27 have been prepared based on all the available knowledge regarding clonal seed. These have been distributed to estates and agency departments in Ceylon.

The Scheme has also had the opportunity of sorting out various collections of clonal seed from several approved sources in Ceylon. The most prolific seed bearers seem to be clone TJ. 1 and PB. 86.

There is ample evidence to show that clone TJ. 1 is a very reliable seed parent, and selfed seed of this clone has given very encouraging results in other countries. In Ceylon on an 18 acre plantation TJ. 'selfed' seed has given very satisfactory results on the first 4 years of tapping, without selective thinning of any kind. Early results with clone PB 86 in other countries have not been altogether satisfactory, but with our knowledge of the variability of clonal seed from collection to collection both in 'selfed' and crossed seed with various male parents, the limited results obtained do not warrant a severe restriction of the planting of PB. 86 clonal seed. For the present, however, it would be unwise to use this seed exclusively on a very large scale. The selection of PB. 86 clonal seed for the production of a white latex similar to its parent is quite unsound. With our present knowledge of the genetics of Hevea brasiliensis there is no guarantee whatsoever that it will breed true to colour of latex or any other factor. Clones MK. 3/2, BS. 3 and BD. 10, GL. 1 are also fair seed bearers. From small scale experiments with hand pollinated seed at Nivitigalakele Experimental Station there is evidence that clones MK. 3/2, WG. 6278 and BS. 3, all Ceylon clones, will be reliable seed parents. Clone BS. 3 is a particularly good seed bearer and has been included in several seed gardens on outside estates, specially supervised by the scheme. The clone is not a very high yielder, and is therefore not found on seed gardens generally approved on estates. Hand pollinated seedlings with clones DBK. 1, PR. 107, M65, M. 162, H. 24 as parents will come into experimental tapping at our sub-station in Hedigalla in the near future and the potentialities of these seed parents can be checked on reliable yield results. Hand pollinated seedlings with clones BS. 3, HC. 28, MK. 1/3, and WG. 6278 have been tapped for two years in Nivitigalakele and a further check up of these seed parents will be possible. We have also included most of the foreign clones, which are to be found in the list of approved sources, in our pollination programmes in 1943, 1944, and 1945. Clones AV. 255, AV. 352 and the RRIM. '500' series clones from Malaya have been included in the 1945 pollinations which produced over 5000 legitmate clonal seeds.

All this seed has been planted out at Hedigalla sub-station and outside estates in 1946 and 1947. These experimental plantings will supply the necessary information on the potentialities of clonal parents found in the seed gardens on Ceylon estates.

In outside countries the high qualities of most of these clones as seed parents have been partially established by trials with hand pollinated seed and seed selected according to parents from near-legitimate seed gardens. A considerable number of these are to be found in the approved sources of clonal seed in Ceylon. Among the better known will be clones TJ. 1, BR 2, PB. 23, PIL. B. 84, TJ. 16, AV. 163, AV. 157 and AV. 152.

Clone TJ. 1 one of the best clone parents known is to be found as the major seed parent on most af the aproved sources of clonal seed in Ceylon, thus increasing the reliability of these sources for clonal seed.

The seed fall in recent years has not been prolific. We are aware, however, that there was more than sufficient seed to meet all requirements, provided orders were placed well before the main seed season, which is in July-August. Our own late requirements of over 25,000 clonal seed were obtained in October, 1950, without any great inconvenience. Estate Superintendents who are anxious to have a good seed set must consider the protection of flowers against Oidium Haveae by sulphur dusting as a routine measure in the future.

APPROVED SOURCES OF CLONAL SEED IN CEYLON.

TJ. 1.	From Dalkeith Estate, Latpandura.
TJ. 1.	From Gonamaditta Block, Waljapola Group, Minuwangoda.
Mixed Seeds of Clones TJ. 1 and TJ. 16.	From approved areas of Blocks B, C and D, Pathregalla Estate, Pothuhera.
TJ. 1 PB. 25, 86.	From Seed Gardens, Milleniya Estate, Paragastota. (Dias Pieris & Co.,)
Illegitimate seed of clones TJ. 1, TJ. 16 and BD. 5.	From approved area in Panigallakande Division, Yatadola Estate, Matugama.
TJ. 1, BD. 5 and GL. 1.	From approved areas in fields Nos. 1 and 2, Frocester Estate, Govinna.
Mixed seed of Clones TJ. 1, BD. 2, 5, 10, DJ. 1, CT. 88, AV. 50, 80.	From approved area in field No. 12, Frocester Estate, Govinna.
Borrowdale A and B Clonal seed.	From Borrowdale Estate, Meegahatenne.
TJ. 1, TJ. 16, Pil.B. 84, PR. 107, AV. 163 and PB. 86.	From approved polyclone area, Kepitigalla Estate, Matale.
TJ. 1, 8, 16, BD. 2, 5, 10, PB. 23, 123, AV. 49, 50, 152, HC. 28.	Mixed clonal seeds from approved area in fields B1, C1, and D1, Millakande Tea Estate, Mahagama.
TJ. 1, BD. 5. GL. 1.	From Monoclone plantings on Mirishena Estate, Govinna.
HC. 28, 55, TJ. 1, 16, BD. 5, 10, PB. 86, 186, 6/50, 5/122, AV. 163, KD. 1, MK. 3/2 and LCB. 1320.	From Polyclone planting on Mirishena Estate, Govinna.
Moneragalla mixed clonal seed.	From approved area at Lower Lachesis Division, Moneragalla Estate, Moneragalla.
TJ. 1, TJ. 16, PB. 86, AV. 157.	From approved area on Nakkala Estate, Moneragalla.
TJ. 1, 16, BD. 5.	From approved Monoclone planting on Lower Division, Durampitiya Group, Getahetta.
TJ. 1, 16.	From approved area, Pussella Group, Parakaduwa.
TJ. 1.	From approved areas on Lewella and Urumiwella Divisions, Urumiwella Grp, Yatiyantota.
TJ. 1, PB. 86, MK. 3/2. WG. 6278, MK. 1/3, HC. 28, BS. 3, DBK. 1, TJ. 1.	From Isolated seed gardens, Kiriporuwa Group, Yatiyantota.

TJ. 1, PB. 86.	From approved Monoclone plantings, Kiriporuwa Group, Yatiyantota.
TJ. 1, PB. 86, TJ. 16.	From approved Monoclone plantings on Dandawa, Dandeniya and Hallina Divisions, Hunuwella Group, Opanaike.
TJ. 1, TJ. 16, BD. 5, PR. 107, MK. 3/2, PB. 86.	From approved Monoclone plantings on Panana and Pallegama Lower Divisions, Pallegama Group, Warakapola.
TJ. 1, PB. 86, MK. 3/2.	From approved Monoclone Plantings on Digdola, Watagoda, Doone Vale, Saumerex, Peelidola, Ginidomini, Yatalamatta, Wattehena, Middle, 52 acre Divisions of Nakiadeniya Group, Nakiadeniya.
TJ. 1, PB. 86, GL. 1.	From approved Monoclone Plantings Higgoda Estate, Undugoda.
TJ. 1.	From approved areas on Kalaella Division, Wellandura Estate, Kahawatta.
TJ. 16.	From approved area Nabuluwa No. 2 Division, Wellandura Estate, Kahawatta.
TJ. 16, BD. 10.	From approved areas of Monoclone plantings on Nabuluwa No. 2 Div: of Wellandura Estate, Kahawatta.
BD. 10, WG. 6278, MK. 3/2.	From approved Monoclone plantings on Kalaella Division of Wellandura Estate, Kahawatta.
TJ. 1. 16.	From approved areas on New Mahawale Division, Mahawale Group, Ratnapura.
TJ. 16.	From approved areas, Panagama, and Raddegoda Divisions, Delwita Group, Rambodagalla.
TJ. 16, GL. 1, BD. 10, WAR. 4, PB. 86, Pil. B 84, TJ. 1.	From approved area, Raddegoda Divisions, Delwita Group, Rambodagalla.
TJ. 16, TJ. 1, BD. 5.	From Monoclone plantings on Block E, Delmella Division, Halwatura Estate, Ingiriya.
TJ. 1.	From approved areas of Monoclone plantings, Halwatura Estate, Ingiriya.
TJ. 16.	From approved Monoclone planting, Block 47, Halwatura Estate, Ingiriya.
PB. 86.	From approved Monoclone plantings, Blocks 84 and 85, Halwatura Estate, Ingiriya.
TJ. 1. BD. 10.	From approved Monoclone plantings, Blocks 100 and 102, Halwatura Estate, Ingiriya.

WG. 6278, MK. 3/2	From approved Monoclone plantings, Blocks 103 and 104, Halwatura Estate, Ingiriya.
PR. 107, Pil. B. 84.	From approved Monoclone Plantings, Blocks 105 and 106, Halwatura Estate, Ingiriya.
TJ. 1, PB. 86.	From approved Monoclone plantings, (No. 1 Garden) Opata Estate, Kahawatta.
TJ. 1, 16.	From approved Monoclone planting, (No. 2 Garden) Opata Estate, Kahawatta.
TJ. 16.	From approved Monoclone plantings, (No. 3 Garden) Opata Estate, Kahawatta.
PB. 86,	From approved Monoclone plantings, (No. 4 Garden) Opata Estate, Kahawatta.
TJ. 1, PB. 86.	From approved Monoclone plantings, No. 5, Division, Pelmadulla Group, Kahawatta.
TJ. 1, 16.	From approved Monoclone plantings, No. 6 Division, Pelmadulla Group, Kahawatte.
TJ. 1.	From approved area of Monoclone planting, Usk Valley Estate, Latpandura.
TJ. 1.	From approved Monoclone plantings, Errabedde Estate, C/o. Poronuwa Estate, Kahawatta.
TJ. 1	From approved Monoclone plantings, Galatura Estate, Kiriella.
TJ. 1.	From approved Monoclone areas, Mipitiakande Estate, Yatiyantota.
Mixed clonal seed TJ. 1, TJ. 16, BD. 5 and MK. 3/2.	From approved areas, Weniwella Estate, Allawwa.
PB. 86.	From approved Monoclone planting, Karandapona Estate, Kegalle.
Mixed seeds TJ. 1 & PB. 86.	From approved areas Mapalagama Estate, Talagaswella.
TJ. 1.	From approved Monoclonal blocks, Pebotuwa Estate, Nivitigala.
Mixed seed GL. 1, TJ. 16, PB. 86.	From approved areas, Kelani Estate Yatiyantota.
PB. 86.	From approved Monoclone planting, Talagaswella Estate, Talagaswella.

GL. 1, Hybrid seed.	From approved area, Talagaswella Estate, Talagaswella.
TJ. 1, TJ. 16 and BD. 5.	From approved Monoclone plantings, on Black-kande Division, Lelwala Grp, Wandurambe.
TJ. 1, TJ. 16, BD. 5 and AV. 49, mixed seed.	From approved polyclone plantings, on Lowmond Division, St. George's Group, Matugama.
TJ. 1 approved hybrid seed.	From Monoclone block on Lowmont Division, St. George's Group, Matugama.
MK. 3/2, DBK. 1. WG. 6278, DK. 5315, PB. 86, PR. 107, BS. 3 and HC. 28.	From Isolated seed garden, Bentota Estate, Elpitiya.
PB. 86 hybrid seed.	From approved Monoclonal block, Bentota Estate, Elpitiya.
TJ. 1.	From approved Monoclonal planting, Bentota Estate, Elpitiya.
TJ. 1, TJ. 16, BD. 5, AV. 352, MK. 3/2, AV. 255, PB. 86, WG. 6278 and PR. 107 mixed seeds.	From approved areas, Tannanena Estate, Pitabeddara.
TJ. 1, PB. 25.	From approved areas, Atale Group, Ruanwella.
WG. 6278, BD. 5, TJ. 1, and TJ. 16 mixed seeds.	From approved Monoclone plantings, Atale Group, Ruanwella.
PB. 86 and GL. 1.	From Monoclone plantings, Udabage Estate, Dehiowita.
TJ. 1, TJ. 16, GL. 1 and BD. 5.	From Monoclone plantings, Udabage Estate, Dehiowita.
TJ. 1, TJ. 16, Pil. B. 84, PR. 107, AV. 152, BD. 2, AV. 56, AV. 80 and AV. 256 mixed seed.	From approved Monoclone plantings, Udabage Estate, Dehiowita.
TJ. 1, TJ. 16, PB. 86, BD. 5, HC. 28 and MK. 3/2.	From approved Monoclonal plantings, Owella Estate, Matale.
GL. 1, PB. 25, TJ. 1, TJ. 16, AV. 163 and Pil. B. 84 mixed seed.	From approved area in field 3, Owella Estate, Matale.
TJ. 1, BD. 5, GL. 1 and PB. 86.	From approved Monoclonal blocks, Eheliyagoda Group, Eheliyagoda.
PB. 86.	From approved Monoclonal blocks, Ederapolla Estate, Bulathkohupitiya.
TJ. 1, TJ. 16, Pil. B. 84, PB. 86, GL. 1, BD. 10.	From approved Monoclonal plantings, Degalessa Group, Yatiyantota.
TJ. 1, TJ. 16.	From approved Monoclonal areas on Kosgolla and Duhallow Divisions, Palm Garden Group, Ratnapura.

PB. 86, Pil. B. 84, TJ. 1, AV. 163, AV. 157, BR. 2 and PR. 107.	From Polyclone Block on Karapincha Division, Palm Garden Group, Ratnapura.
TJ. 1, TJ. 16 and GL. 1.	From approved Monoclonal plantings, Clunes Estate, Dehiowita.
TJ. 16, PB. 86 and GL. 1.	From approved Monoclonal plantings, Ganapalla Estate, Yatiyantota.
GL. 1 and TJ. 1.	From approved Monoclonal plantings, Gikiyanakande Estate, Neboda.
TJ. 1.	From approved isolated Monoclonal block, Monerakelle Estate, Moneragala.
TJ. 1, TJ. 16, GL. 1, PB. 86.	From approved Monoclone plantings, Mutwagalla Estate, Kiriella.
TJ. 1, 8, 16, BD. 2, 5, 10, AV. 49, 50, 80, 256, PB. 25, 186, GL. 1, HC. 28.	From approved Polyclone plantings, Pantiya Estate, Neboda.
TJ. 1, 16, BR. 1, 2, PB. 25, 86, 186, AV. 255, 352, 152, 163, Pilmoor B. 84, M/K 3/2.	From approved Polyclone plantings, Pantiya Estate, Neboda.
PB. 86, MK. 3/2	From approved Duoclone planting, Pantiya Estate, Neboda.
TJ. 1, GL. 1, PB. 86, PB. 186, Pil. B. 84.	From approved plantings, Vincit Estate, Waharaka.
TJ. 16, GL. 1, PB. 86, BD. 10.	From approved Monoclone plantings, Walpola Group, Dehiowita.
TJ. 1, TJ. 16, PB. 86 and GL. 1.	From approved Monoclone plantings, We Oya Group, Avissawella.
PB. 86.	From approved Monoclone planting block, Yogama Estate, Dehiowita.
TJ. 1. GL. 1, BD. 5, PB. 186 and PB. 25.	From approved Monoclonal plantings, Gikiyanakanda Estate, Neboda.
TJ. 1, 16, GL. 1, PB. 86, BD. 5, MK. 3/2, WG. 6278 PIL. B. 84, PR. 107. LCB. 1320, PB. 25.	From approved Monoclonal plantings, on Densworth Division, Moralioya Grp., Ruanwella.
TJ. 1, TJ. 16, PB. 86, AV. 157.	From approved area, Nakkala Estate, Moneragala.
TJ. 1.	From approved Monoclone block in 1937. and 1938 clearings, Sunderland Estate, Eheliyagoda.
TJ. 1, 16, BD. 2, 5, 10, AV. 49, 50, 163, AD. 12, AD. 15, GL. 1. M. 191, L. 28, TK. 26, RUB. 393, SAB. 24.	From approved Polyclone areas in the 1927, 1935, 1936 and 1937 clearings, Udapolla Estate, Polgahawela.
TJ. 1. GL. 1., BD. 10, PB, 86.	From approved Monoclone areas in the 1938 and 1947 clearings, Udapolla Estate, Polgahawela.

TJ. 1, 16, GL. 1, BD. 10, PIL.B. 84.	From approved Monoclonal blocks, Yogama Group, Dehiowita.
TJ. 1, 16, GL. 1, BD. 5, PB. 25, PB. 186. and HC. 28.	From approved Monoclonal blocks, Walahanduwa Estate, Galle.
TJ. 1, 16, BD. 2, 5, 10, PB. 25, 86, 186, AV. 49, 50, 255, 352, PIL.D. 65, PIL.B. 84, MK. 3/2, WG. 6278, W. 259, HC. 28, 55, KOB. 41, GL. 1, PR. 107, RUB. 393, DJ. 1, SAB. 24, TK. 12, MX. 1, MX. 2, M. 113, PRANG BESAR "FRACTION" CLONES.	From approved Monoclone, Duoclone and Polyclone plantings, Sorana Estate, Horana.
PB. 86, WG. 6278.	From approved Monoclonal blocks, Wagga and Halpe Group, Tummodera.
TJ. 1, TJ. 161, PB. 25, 86, MK. 3/2, GL. 1.	From approved Monoclone plantings, Ellakande Estate, Horana.
TJ. 1, TJ. 16. and PB. 86.	From approved Monoclonal blocks on Woodend Estate, Dehiowita.
PB. 86, WG. 6278, MK. 3/2, and TJ. 1.	From approved Monoclonal blocks on Wagga & Halpe Group, Tummodera.
TJ. 1, PB. 86, GL. 1, BD. 5, PB. 25, and WG. 6278.	From approved Monoclonal blocks on Elston Estate, Puwakpitiya.
TJ. 1, TJ. 16, BD. 5, GL. 1, MK. 3/2, PB. 86, HC. 28.	From approved Monoclonal blocks on Hathmatte Estate, Ruanwella.
TJ. 1, HC. 28, BD. 5, PB. 86.	From approved Monoclonal blocks on Vogan Estate, Neboda.
TJ. 1, TJ. 16, BD. 5, GL. 1.	From approved Monoclonal blocks on Rayigam Estate, Ingiriya.
TJ. 1, TJ. 16, GL. 1, PB. 86, PB. 25, HC. 28, HC. 55, MK. 3/2, WG. 6278.	From approved Monoclonal blocks on Tempo Estate, Neboda.
TJ. 1.	From approved Monoclonal blocks, on Kendawa Estate, Bulathkohupitiya.
TJ. 1, 16, PB. 25, 86, 186, BD. 5, GL. 1, Pil.B. 84, PR. 107, HC. 28, MK. 3/2, WG. 6278.	From approved Monoclonal blocks on Galawatta Division, Yatadola Group, Matugama.
TJ. 1, BD. 5, 10, PB. 86, HC. 28.	From approved Monoclonal blocks on Galawatta Division, Yatadola Group, Matugama.
TJ. 1, PB. 86.	From approved Monoclonal blocks on Maldeniya Estate, Dehiowita.
MK. 3/2, WG. 6278, DK. 5315, HC. 28, BR. 2, PR. 107, DBK. 1, BS. 3.	Seed Garden, Niriella Estate, Nivitigala.
TJ. 1, PB. 86, GL. 1, BD. 5.	From approved Monoclonal blocks on Langsland Estate, Neboda.

SOME STATISTICS ON RUBBER PRODUCTION.

The following figures have been obtained from various sources and will probably be of interest to the planting community generally :—

(1) RUBBER EXPORTED FROM CEYLON.

	(a) 1948 Tons	(b) 1949 Tons
Sole Crepe	7,296	1,185
Liquid Latex	625	878
Latex Crepe	21,776	
Scrap Crepe	13,334	82,426
Scrap	8	
Sheet	48,787	
	91,826	90,489

(a) Obtained through courtesy of Deputy Chairman, P. A.
(b) Obtained through courtesy of Acting Rubber Commissioner.

(2) PRODUCTION ACCORDING TO GRADES :

No official records are available of the proportions of the various grades in each category and I am indebted to the Ceylon Chamber of Commerce for the following estimates :

Estates Crepe Production	—	No. 1	— 70%
		No. 2	— 20%
		No. 3	— 10%
Estates Sheet Production	— R.R.S.	No. 1	— 90%
		No. 2	— 5%
		No. 3 & Lower	— 5%
Smallholdings Sheet Production	R.R.S.	No. 1	— 45%
		No. 2	— 25%
		No. 3	— 20%
		No. 4 & lower	— 10%

(3) YIELDS IN CEYLON :

from Administration Report of Rubber Controller, Ceylon :—

	Acreage	Rubber Production in tons.		Production per acre in lbs.	
		1947	1948	1947	1948
Estates above 100 acres	353,213	54,191	58,899	344	374
Estates below 100 acres and smallholdings	280,002	34,809	36,101	278	289
Total.....	633,215	89,000	95,000	315	336

(4) YIELDS IN MALAYA & INDONESIA:

from Rubber Statistical Bulletin, Vol. 4, 1950.

	Acreage	Production 1949 — tons	Production per acre lbs.
Malaya — Estates	1,963,950	400,815	457
Smallholdings	1,425,616	270,688	425
Total	3,389,566	671,503	444
Indonesia — Estates	1,566,976	167,210	239
Smallholdings	1,806,516	263,851	327
Total	3,373,492	431,061	286
Indo-China - Total	332,234	43,010	290
World — Total	9,400,000	1,487,500	354

Note: The acreage figures given above are for total acreage under rubber. When only acreage in tapping is considered yield per acre is much higher.

Figures are available only for estates.

	Approx. Acreage in tapping	Total Yield	Yield in lbs/acre
Malaya	1,620,000	400,815	554
Indonesia	500,000	167,210	749

(5) YIELDS OF BUDDED RUBBER:

In Malaya — 25.4% of the estate acreage is planted in high yielding rubber and production estimates are available for this.

Estimates for the year 1950, based on January-July production are as follows (from Rubber News Sheet, October 1950).

Per tapped acre/an.	European	Chinese	Indian	Others	Total
Ordinary	470	400	378	326	449
High Yielding	851	775	543	634	827
Total	557	452	396	392	528

Java — 30 — 35% of estate rubber is of high yielding type and production of 1500 lbs/acre is normal. In many plantations 1,800 lbs/acre and more is being produced. (Estate rubber covers 364,000 acres).

Quoted from W. H. de Jong—"Verslag eerste Planters Byeenkomst Sept. 1946" Amsterdam 1947.

East Coast Sumatra—Maas states that 1,200 lbs/acre is quite normal on estates and that 40—45% of the estate area of 555,000 acres is in high yielding rubber.

J.G.J.A. Maas :—Arch. v. Rubbercultuur—1948. 26. 19.

Ceylon — The Rubber Controllers' report for 1948 and 1949 gives the total acreage of high yielding rubber as 42,784 acres, while new plantings (mostly middle and peasant class) accounted for 26,569 acres. Even taking into account this latter area, and assuming that it is all planted up in high yielding rubber the area of high yielding rubber in Ceylon is only 10% of the total acreage.

Much of Ceylon's replanted rubber is still young. Returns from some estates are given in an article in this Number, and the following information for clearings of 10 years of age has been extracted from these returns.

The yield from 10 year old clearings has been selected because this is the greatest age at which there is a reasonable acreage to work on. Most of these clearings were in their 4th tapping year.

Planting District	Acreage	Total Yield lbs.	Yield/acre lbs.
Negombo	26	22,544	867
Kurunegala	19	15,252	802
Kegalle	309	212,992	689
Kelani Valley	1592	1,045,671	657
Kalutara	2665	1,726,967	648
Galle	272	172,582	635
Matale	217	132,718	611
Ratnapura	1753	887,203	506
Total	6853	4,215,929	615

Although an increase over the figure of 615 lbs/acre can confidently be expected it would appear that Ceylon's yields are behind those of other countries.

ON MANURING AND RELATED PROBLEMS IN RUBBER.

INTRODUCTION

THE Scheme has had many requests in recent months for guidance in the use of fertilizers. Some of these requests indicate a belief that fertilizers will unfailingly increase and/or prolong high yields. This is by no means the case and this circular is written to advise why, when and how to use fertilizers.

Before discussing the Why of fertilizers, it is essential to understand something of how soils are formed and how they are maintained.

On the Nature of Soil

Soil is not something fixed or permanent, but is only one stage in a long cycle of changes. Soil is made from decomposition of rocks and the activities of micro-organisms. The rocks supply the mineral constituents of plants such as calcium, potassium and magnesium and the acidic constituents such as phosphate while one of the most important plant foods, nitrogen, is obtained from the air, through the activities of micro-organisms in the soil which "fix" the nitrogen and so provide compounds on which the plants can feed.

We can see the beginnings of soil formation on rock faces where only such lowly plants as lichens can succeed. These as they die form food for micro-organisms, which in their turn help further in the process of soil formation. The roots of small plants probe and penetrate into tiny crevices. Sun and air and water play their part in disintegration. Finally the once solid rock is broken down to fine particles of transformed materials intimately mixed with the organic remains of plants and other living matter, to form the complex mixture we know as soil.

Soil is not present for all time; it is constantly being destroyed and if a soil is to remain, it must be constantly formed anew.

Tropical soils, as they are formed, contain much sand and little clay. Hence their water holding power is very low and their nutrient food reserve, which depends on the clay, is also very low. The high sand content makes them very porous and so in high rainfall conditions - as most rubber areas - the nutrient status of the soils is further lowered since some of the plant foods are washed out of this soil. This washing out process is known scientifically as leaching and in actual fact many of our rubber soils are dangerously near the stage of being "fully leached".

Cover crops in relation to soil processes

We can help in retaining plant foods in the soil by incorporating humus. In temperate countries this is accomplished by adding pen manure, or by ploughing in green manure. In the humid tropics perhaps the best method is to grow cover crops with extensive rooting systems. These also keep the soil from exposure to the heat of the sun and from desiccation by wind and so provide conditions for the retention of humus in the land.

It has been previously pointed out that living organisms play a very great part in building up and in maintaining soils. These organisms require a cool, moist, and steady environment if they are to function properly and good covers provide such conditions.

Soil aeration has not been discussed so far, but the living organisms in the soil as well as the rubber roots themselves require a plentiful supply of oxygen. Soils which are exposed to wind and weather tend to "pack" - the finer particles are washed down into the air spaces and the stones and gravel are left on the surface. This hinders aeration. Covers which protect the soil from exposure, prevent this packing and so improve aeration.

Good soil covers therefore maintain the soil in a physical condition where the manifold activities which lead to soil formation can proceed under favourable conditions. They also add humus to the land and so they both increase the supply of plant food, and also help to retain it in the soil against the leaching activities of rainfall.

There is one further point to be borne in mind. Covers must at all times be subservient to the main crop - rubber. They must not be of the type which, given an opportunity will dominate the rubber. Sod forming grasses and ferns (Cleichenia) are probably of this type since they form a surface mat of roots which "smother" the rubber roots below them. As such, they should be frowned upon. Covers such as Pueraria and Desmodium ovalifolium do not form this compact root mass and do not dominate the rubber, given a little control, and so are excellent covers.

It should not be overlooked, of course, that the ideal cover for a rubber estate is the canopy of the rubber itself. If this can be brought to a stage at which no ground cover can exist beneath it, it will give protection to the soil and at the same time, one can be assured that the growth of the rubber leaves little, if any, room for improvement. Really good rubber is automatically clean weeded rubber.

With this brief and necessarily incomplete picture of soils in mind, it is possible to discuss soil improvement.

Soil Improvement.

The first stage in soil improvement is to make the best of the soil you have got. See that it is protected against erosion. See that the covers are of a desireable type - if not, try to establish desirable types by supplying them and by selective weeding.* If these methods fail to bring about the desired improvements, then consider the use of fertilizers.

There is a tendency in Ceylon to regard the use of fertilizers as all that is necessary for good agriculture. This is wrong, and no one should attempt to substitute fertilizers in place of good agriculture. Fertilizers can be a tremendous help but they must always be used with discretion. Every effort should be made through cultivation practices to improve conditions before fertilizers are used - and fertilizers should be used only when the trees will not grow or yield as they should without them. This applies to both young and mature rubber.

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* Selective weeding does *not* mean removing the soft weeds and conveniently leaving the harder-to-eradicate cheddies to a later date which may never materialise. The hard cheddies and volunteer rubber seedlings should be the first to go.

If the parent rocks are deficient in certain plant foods, then the soil from them is also likely to be deficient in those foods - and fertilizers can be used to remedy these deficiencies. Alternatively, the plant foods may be there all right but in a form unavailable to the rubber tree. This happens very frequently with phosphates which combine with the iron in the soil to form a compound which the plant cannot utilize. Under these conditions phosphate must be added to the soil regularly.

If your covers are non-existent and the soil has been exposed to sun, wind and rain so that its humus content has disappeared and aeration has almost ceased, it is possible that the nitrogen fixing organisms are unable to do their job. properly. In such circumstances it may be necessary to add a nitrogenous fertilizer to help plants to grow and so bring the soil back into a better state where it can itself produce the nitrogen compounds required for further plant growth.

RUBBER MANURING

General Considerations.

In discussing rubber manuring it is first of all essential to define the advantages to be anticipated from manuring. These are threefold.

(a) Enhanced early growth so that trees reach tappable size more quickly;

(b) An increased yield during maturity as compared with non manured trees;

(c) A longer productive period - i.e. the onset of senescence should be delayed, and the rate of senescence when it does set in, reduced.

These advantages do not necessarily follow the use of fertilizers. The conditions under which responses to the different fertilizers may be expected are outlined below.

Rubber is a most peculiar crop in that the latex we remove from the tree contains only insignificant amounts of plant foods. With other crops such as tea and coconuts and sugar cane we remove very large quantities of plant foods in the crop, and with these crops, addition to the soil of fertilizers to compensate for plant foods removed as crop forms a rough and ready basis for fertilizer practice. Obviously this basis cannot be applied to rubber.

Apart from clonal variations, the amount of latex obtained from a tree depends on its size, which in turn controls the number of latex vessels. When we are *growing* young rubber the aim generally is to get a maximum rate of growth, but once tapping starts the rate of growth is drastically reduced. The aim is no longer to accelerate growth, but to maintain growth (at a very reduced rate) so that the bark remains in a suitable state for tapping for many years ahead. The fertilizer requirements of mature trees in tapping may be, and probably are, very different from those of growing trees.

There is still a further point to be considered in the previous history of the land under consideration. Some rubber was planted on old tea or coffee lands. From modern knowledge, it is highly probable that the initial fertility of such lands was not maintained under these crops. It is now known that tea may deplete the land of potash after several years of cropping and consequently rubber following on tea may suffer from a potash deficiency inherited from the tea days. Similarly a good deal of rubber replanting is now going on on lands which were utilised for food crop production during

war years. Manioc and sweet potatoes are exhausting crops and rubber planted after such crops may have especial need of heavy fertilizing to restore depleted soil reserves, particularly of potash.

It will be obvious that there can be no one "prescription" suited for all needs. Each and every estate - and more than this, each and every field, must be considered on its own merits. In very wet areas, in slow drying areas such as slopes with a western aspect, and with clones with heavy compact crowns, it may be desirable to restrict the canopy by restricting manuring so that air circulation about the trunks will permit earlier panel drying and tapping. Similar considerations apply to areas exposed to high winds.

Indicators.

In this discussion on manuring it is suggested that the state of the cover crops and of the canopy should be used as indicators of soil conditions and of the state of the tree respectively. These characteristics have been suggested because they are subject to comparatively rapid visual changes. In mature rubber it is true that the ultimate factors concerned are yield and renewal of bark but changes in these characters will doubtless be much slower than changes in cover and foliage. As a first approximation it may be assumed that good covers and good foliage will automatically lead to good yields and good bark renewal, but obviously these characters should not be neglected and should be checked whenever possible. Girth increases are seriously affected by tapping, but even rubber in tapping should show regular, if small increases in girth.

With young rubber, girth is an excellent indicator of growth and should be used as such. References to "backward growth" and "not growing as well as it should" refer primarily to girth increases. Once rubber is established, girth increments should be at least 3" per annum and can with advantage be greater than this.

By far the finest guide to growth is the appraisal of the Superintendent. Although I have stressed certain characters, close inspection by an experienced superintendent will take into account not only these characters but many others which are not easily measureable.

In time it ought to be possible to build up a body of experience over a very wide range of soil and climatic conditions in Ceylon so that much of the guess-work which must necessarily exist at present can be avoided. A start was made on a wide range of experiments in 1938-1939, but unfortunately these experiments were wartime casualties and will have to be started again. The advice given below should not be regarded as certain and definite, but merely as an indication, to be modified by special circumstances if such exist.

Mature Rubber.

From all the evidence available, it is useless to expect mature seedling rubber to give quick responses in yield to added fertilizers.

There is some evidence from other countries that the rate of senescence may be slowed down by fertilizers. There is a widespread *belief* in Ceylon that the slowing down of senescence also holds here, but critical evidence on this point is lacking.

I know of only two controlled experiments with old rubber in Ceylon and these have shown no benefit at all from added nitrogen, potash or phosphate.

This does *not* mean that no old rubber in Ceylon will benefit from fertilizers - it only means that we have no factual basis to work on. I suggest that the manuring of old rubber be approached in the following manner.—

(a) When the canopy is normally so dense that nothing will grow underneath it, there seems little point in trying to improve the canopy. Under such circumstances I do not think that fertilizers will be of any help at all.

(b) Where the canopy is not as good as it might be but where covers are luxuriant, it is unlikely that the common fertilizers will be of any benefit. This is actual experience on Dartonfield. It is becoming increasingly apparent that neither nitrogen, phosphate nor potash is the answer to this problem.

(c) When both canopy and covers are poor, there seems hope that fertilizers may bring about improvement. At this stage of affairs, efforts should be directed towards improving the covers. This will lead to improved soil conditions and it may be expected that these improved soil conditions will lead to better rubber. I would suggest that a simple experiment be started up whenever possible, using nitrogen, phosphate and potash one at a time to see which gives a response. Additionally, all three should be tried together. Practical experience has shown that phosphate (in the form of Saphos) is the fertilizer most likely to bring about improvement in cover crops.

Where it is not feasible to try the matter in this way, a complete fertilizer mixture should be given, consisting say of 2 parts Saphos and one part each of ammonium sulphate (the only easily available nitrogenous fertilizer) and potash. If a crude potash salt containing magnesium is available, this should be used in preference to purer potash salts.

This mixture should be applied at the rate of 1 lb. per tree every three months. I am strongly in favour of soluble fertilizers being applied in small frequent doses - small because this avoids burning the existing covers, and frequent because the plants have an opportunity to use them before they are washed out of the soil. If the covers are very thin, it may be desirable to fork the manure lightly into the land. Bare land tends to have a glazed surface, where rain (and dissolved fertilizer) runs off, rather than soaks in. *If this treatment does not bring about improvement in either the canopy or the cover crops within, say, the first year, there is little point in continuing it.*

If the canopy and/or cover, shows a response to fertilizer, application of the particular fertilizer should be continued only if necessary to maintain the improvement. The crop may show no immediate increase over the unfertilized trees, but there can be little doubt that the improvements noted will delay senescence.

To sum up, fertilizers should only be used in old rubber where both canopy and cover are below normal, and where a quick response to added fertilizer can be obtained in one or both these characters.

Young Rubber

There is, fortunately, rather more experimental evidence available for young replanted rubber than there is for old mature rubber. There is moreover, general agreement in results in all the rubber growing countries of the Far East in certain instances.

Phosphate.—The Scheme's own experiments, covering its three estates, show a very definite increase in early growth rate in response to phosphate. This has been confirmed on other estates in Ceylon and in other countries.

The Malayan conclusion that "we can state with confidence that a marked beneficial effect can be expected in replantings" where phosphate is added applies equally well to Ceylon. The extent of this response does vary from one estate to another, and will no doubt depend on manuring history previous to replanting. An estate which has regularly manured its old rubber with one of the standard mixtures containing rock phosphate, will probably get only small response to further added phosphate, but on lands which have not hitherto received adequate phosphate, a definite response may be looked for.

Estates which have not hitherto used much rock phosphate should see that their replantings have an adequate supply - say 1/4 lb. per planting hole followed by 1/2 lb. when the plants are established applied in a narrow zone around the young trees. Further dressings should consist of 1 lb./tree at the end of the first year, and 2 lb./tree at the end of the second, fourth and sixth years. This amounts to a dressing of nearly half a ton per acre by the time the trees come into tapping.

What little evidence is available suggests that phosphate is essential during the growing phase, and that its effect diminishes as the trees reach maturity, so that it is not necessary to give much phosphate to the mature tree. The heavy dressing given during the growing phase should be available to the tree for some considerable time after application has ceased.

Early application should be in a close band around the young plant, with later applications at an increasing distance, and covering a wider band. There is a diversity of opinion as to the manner in which rock phosphate should be applied. There is some evidence against the use of a few large pockets, but there seems little objection to numerous small pockets, or to broadcasting and then lightly forking into the land.

Nitrogen.—In the past, Nitrogen has been the main constituent of fertilizer mixture for young rubber. *I know of no evidence in Ceylon in support of this practice.*

The Scheme's own experiments indicate no response in either growth rate or in yield to added nitrogen. A series of experiments on young rubber begun on estates in 1938, and abandoned during the war indicates that the response in girth, if any, was small. Out of eight experiments, only one showed a response to nitrogen; this was about half the size of the phosphate one.

In these circumstances, Nitrogen cannot be generally recommended as a constituent of fertilizer mixtures.

These results in Ceylon are similar to results obtained elsewhere. Thus Communication 267 (March 1950) from Malaya, in discussing replanting experiments states "there has been a marked response to treatment with phosphate, but the other two major nutrients (nitrogen and potash) had little or no effect on the growth of the rubber plants".

This confirms earlier reports from Malaya in which only phosphate gave increase in yield.

Nitrogen should only be used when growth is backward. This is essentially the same advice given by the Scheme in 1941 - "apply phosphate only in areas where the general level of growth is satisfactory. For backward areas or backward trees, the use of an NPK mixture is advised'.

Potash.—Dartonfield experiments generally do not indicate any advantage from potash. The 'Standard' rubber fertilizers R215 and R400 contain small amounts of potash on the 'insurance' principle.

I am convinced from evidence available to me that potash deficiency is more widespread than has hitherto been acknowledged. Of the eight experiments on young rubber on outside estates, commenced in 1938, three showed a response to potash. An estate near Dartonfield has found that potash added *in addition* to that in the standard fertilizer mixture, has increased the rate of growth appreciably so that the percentage of trees in tapping on the treated plots as compared with the 'control' is more than doubled.

On Dartonfield itself, the cover crops on one area of land have shown a marked response to potash, and there is no reason to doubt that the better cover will in due course lead to better rubber.

If your young rubber does not do so well as it should or if it shows reddish brown colours when it should be green, then try the effect of 1/2 lb./tree of potash. Potash should not be used unless there are indications of need for it, for there is some evidence that it may depress yield when present in excess of requirement.

Young Rubber in Tapping

There is a marked dearth of evidence on the effects of fertilizers on young rubber in tapping of, say, from 10 - 20 years old. All that can be suggested is that the canopy should be carefully watched and on the slightest signs of degeneration, the methods suggested for mature rubber should be employed. Additionally, if a particular soluble fertilizer has been of use in the growing period, e.g. potash, care should be taken to add this particular fertilizer during maturity. I have suggested canopy rather than yield as a criterion for judging the need for fertilizers, for yield can be affected by panel troubles, e.g. brown bast, but obviously every attention should be paid to yield and if this begins to fall off without obvious reason, steps should be taken to discover the cause.

Replanting

Under 'Phosphate' the use of liberal supplies of phosphate in the planting holes and during the plant's early life has been advocated. Young rubber particularly requires attention in its first few months of life to see that it gets 'off the mark' well and starts to grow lustily. During the digging and refilling of the hole and during planting operations, the soil is so disturbed that the normal organic activity may be completly upset and so nitrogen fixation may be greatly reduced for a time. It is to be regretted that compost and/or animal manure is not normally available in sufficient quantity to add to each planting hole. As an alternative to ensure a rapid start, a 'complete' fertilizer, such as a nitrogen, potash, magnesium and phosphate mixture at the rate of 2 ozs. every three months or a 'natural' fertilizer such as Animal Meal at the rate of 4 ozs. every three months could be used with advantage. Such applications could be restricted, after the first two or three applications, to backward plants.

'Tonic' Manuring

In certain cases, such as after severe defoliation from Oidium or Phytophthora, it may be desirable to use fertilizers to help the tree regain its normal state again. Assuming that rock phosphate has been regularly used, there is little need to include this in the tonic, which might very well contain principally the ingredients lost in the leaf fall - i.e. nitrogen and potash. In such cases 2 lbs. ammonium sulphate and 1/2 lb. potash (potash-magnesium if possible) per tree could be used with advantage. Of course, a much better procedure would be to prevent Oidium or Phytophthora damage, so that a tonic becomes unnecessary.

Conclusion.

These recommendations are substantially the same as made by the Scheme in past years. The only points I wish to emphasize are:—

(1) that there are wide variations in the fertilizer responses of rubber soils and that by far the best way of proceeding is to find out by direct experiment which fertilizer gives a response on a particular soil, and

(2) that I am very conscious that the programmes advocated above have already been applied in certain cases and have not produced the desired results. There is a great need for investigations in Ceylon into the effects of magnesium (which I believe to be short in many areas) and on the effects of the so-called minor elements.

The Scheme will be greatly interested to learn of cases where the standard fertilizer programmes do not produce the desired results.

4th November, 1950.

SUMMARY OF RECOMMENDATIONS

(1) Before you consider using fertilizers, do all you can in the way of good cultivation to improve the soil. Fertilizers should be *additional* to and not a *substitute* for good agriculture.

(2) Be clear as to what you expect from fertilizers and do not expect miracles.

(3) **Old Mature Rubber:**

(a) Inspect your rubber carefully and decide where improvement is possible. Your best hopes of improving old rubber is to see that your covers are in good order.

(b) If the land is hard and nas poor covers use a complete fertilizer, or better still, run a small experiment to see which fertilizer or fertilizers bring about an improvement in cover and/or canopy. Suggested levels are 2 lbs. Saphos, 1 lb. ammonium sulphate and 1 lb. potash per tree per annum, applied as frequently as convenient (e.g. 1/2 lb. Saphos, 1/4 lb. ammonium sulphate/and 1/4 lb. potash every three months). If there is no response within a year there is little point in continuing the treatment. Saphos is the fertilizer most likely to give a response.

(c) If your covers are of a desirable type (Pueraria or Desmodium ovalifolium) and are growing luxuriously, or when the canopy is so dense that nothing will grow under it, it is unlikely that fertilizers will bring about any improvement.

(4) **Young Rubber not in Tapping:**

(a) Young replanted rubber will almost certainly respond to phosphate. The amount to be used will naturally depend on the phosphate treatment of the land before replanting commenced. Where there has been no phosphate added previously, then use:—

1/4 lb. Saphos in the planting hole

1/2 lb. Saphos per tree when the plants are established

1 lb. Saphos per tree at the end of the first year

2 lbs. Saphos per tree at the end of the 2nd, 4th and 6th years.

(b) If your rubber does not grow as well as it should, or if the foliage shows reddish brown colours when it should be green, try the effect of 1/2 lb/ tree of potash. Do not use potash generally until you have demonstrated the need for it.

(c) Under normal circumstances, young growing rubber should not require nitrogen.

(5) **Young Rubber in Tapping:**

(a) If adequate phosphate has been added in the growing stages, fertilizing with phosphate should cease. A close watch should be kept on the general appearance of the trees, and if the canopy shows signs of deterioration, or if the yield does not increase as it should or actually falls off, every effort should be made to find out the cause.

(b) In these cases where a *soluble* fertilizer has been necessary during the growth period (e.g. potash) this should continue to be added at a reduced rate during maturity.

(6) **Replanting:**

It is essential to get young rubber plants well established and growing lustily from the very start. In addition to the regular use of phosphate, it is desirable to add manure or compost to each planting hole, or where this is not possible, to replace it with a complete fertilizer. The Scheme is now using 4 ozs. Animal Meal applied soon after planting. The quantity is repeated at three monthly intervals to backward plants. In place of Animal Meal, a mixed fertilizer containing 2 parts ammonium sulphate and 1 part potash could be used at the rate of 2 ozs. per plant. These fertilizers are in addition to the rock phosphate recommended under (4.)

(7) **'Tonic' Manuring:**

Use 2 lbs. ammonium sulphate and 1/2 lb. potash per tree. If no phosphate has been added in the normal regular programme, 1 lb. rock phosphate could be added to the mixture.

4th November, 1950.

E. PHILLIS, PH D. D. SC.,
Director.
RUBBER RESEARCH SCHEME,
CEYLON.

FRACTIONATION OF LATEX BY NATURAL COAGULATION.

A FEW months ago there were widespread complaints that the standard of blanket crepe exported from Ceylon was deteriorating. The chief reason for complaint was a change in colour between despatch from Ceylon and arrival in consuming centres. Changes in colour included not only coloured spots, black or red or green, but a general change in body colour which could be equivalent to a full grade and more.

Investigation indicated no one specific reason for these complaints, but it would appear that the trouble was related to 'mushroom' factories which took advantage of the price differential between sheet and crepe, and manufactured 'bought' latex without adequate facilities. In particular, there would appear to have been inadequate milling and washing, and the change in colour on standing was doubtless due to poor removal of serum substances.

During investigation on this complaint, it was felt that impure water supplies might be a contributory cause and so attempts were made to reduce the amount of water used in preparation. It soon became obvious that the use of water for *washing* the coagulum should not be restricted in any way, and so attention was directed to the coagulation procedure.

The following procedure was finally arrived at, and is given here because, in our experience, it gives a bulk product which is definitely lighter and brighter than that given by the standard methods involving dilution with water.

The main points of the procedure are that the latex is not diluted before coagulation, and that advantage is taken of natural coagulation to cause the formation of a 'first fraction'. Once the first fraction has been formed and removed, the remaining bulk of the latex shows no further tendency to precoagulate and remains perfectly fluid for many hours.

(1) Latex is strained twice through 40 mesh sieve and bulked in tank.

(2) D.R.C. of bulk latex taken with glass metrolac. Our latex runs between 3 and 3½ lbs. D.R.C. This goes on without dilution. If the D.R.C. is above 3½ lbs., it would probably be worth diluting down to 3 lbs.

(3) Sodium Bisulphite is added at the rate of 8 ozs./100 lbs. dry rubber dissolved in 40 parts of water.

(4) Stir for 5—10 mins. to get thorough mixing and then let stand for 2½—3 hours.

(5) After this period, inspect the latex at intervals for signs of clotting. When this begins (usually 4—5 hours) stir well with a paddle for upwards of an hour, until all the tiny clots are merged into big clots which can be lifted out. These big clots can either be handled at once or left under water till next morning.

(6) Next morning, run the latex from the first tank, through a filter, into a second, add acetic acid (10 ozs. to 100 lbs. dry rubber, diluted 1—30) and mix well. Coagulation should be complete in $2\frac{1}{2}$—3 hours.

(7) The first fraction varies from 15—18% under Dartonfield conditions but I understand that the amount varies from estate to estate.

The procedure has been tried on a few estates and in some cases an improvement has been noted, while in others there appears to have been no advantage.

The method is not very suitable for sole crepe manufacture since it is difficult to get fine, smooth compact laces of the desired width. The laces tend to be 'pebbly' and adhesion between laces in the finished product is not all that it might be.

No such disadvantage has been noted in blanket crepe manufacture. The method has been in standard use at Dartonfield for a little over a year now.

Director.

Dartonfield,
Agalawatta.

30th November, 1950.

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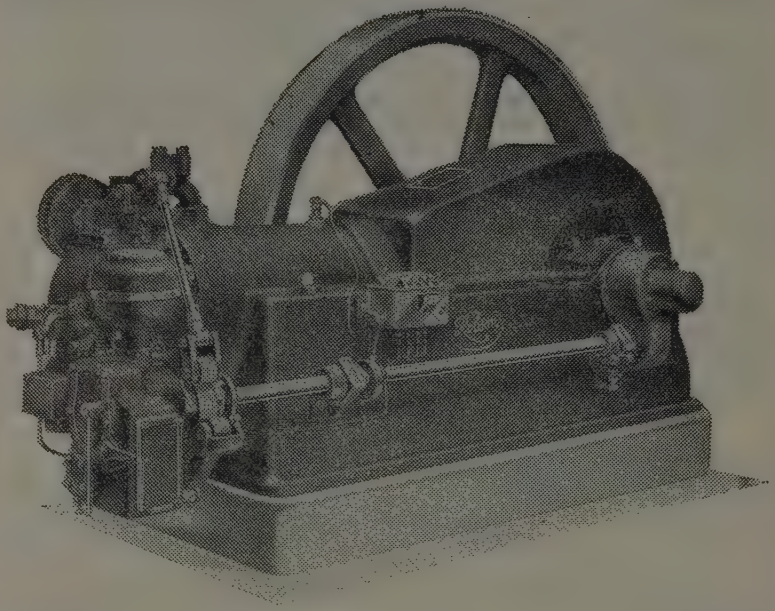

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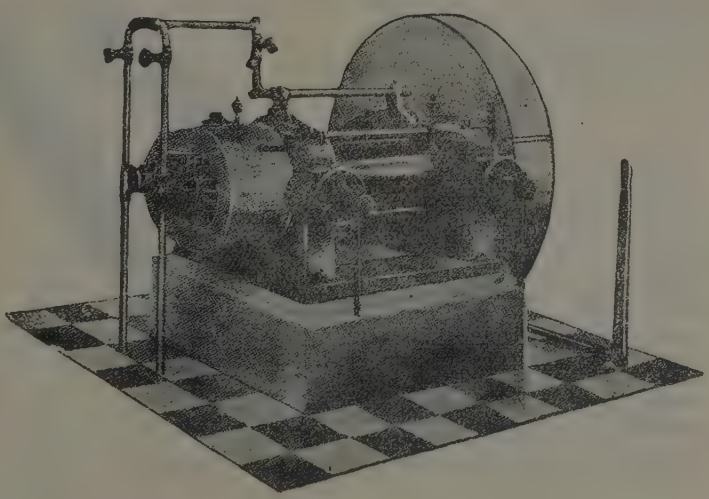

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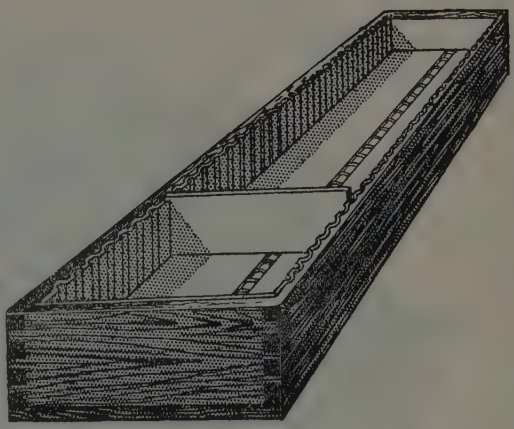

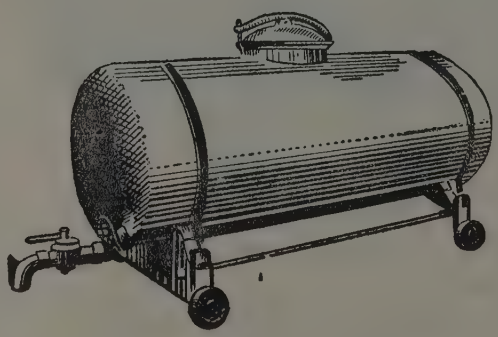

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